Loss of Pressure Through Heater Coils, With Formula

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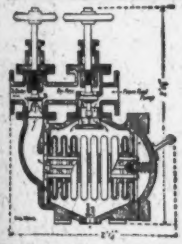

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THE HEATING AND VENTILATING MAGAZINE

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Loss of Pressure in Blowing Air Through Heater Coils, With New Formula

TESTS SHOWING IMPORTANCE OF POINT GENERALLY OVERLOOKED IN INDIRECT HEATING WORK

BY E. M. SHEALY,

Assistant Professor of Steam Engineering, University of Wisconsin.

In designing ventilating systems, it is necessary to know the resistance offered to the flow of air by the entire system of air passages, in order that the proper size of fan for delivering the required quantity of air may be determined. If a certain size of fan is installed and run at a certain speed, the quantity of air delivered will depend upon the resistance of the delivery system; the greater this resistance, the less will be the quantity of air delivered.

The resistance offered by various forms of piping used in ventilating systems is well known, and need receive no further attention here. Upon searching for information relative to the resistance offered by the heater coils, which forms a part of the delivery system of practically every ventilating installation, the writer found a surprising dearth of data. The little data which could be secured, although somewhat unreliable, pointed to the fact that the loss of pressure as the air passes through the heater coils amounts to a large portion of the total pressure generated by the fan.

When one considers that the path taken by air in passing through heater coils is very complex, winding in and out among the rows of pipe, and that the velocity of the air passing through the coils is usually high, from 800 to 1200 ft. per minute, it is not surprising that there is considerable loss of pressure in this part of the system.

To the writer's knowledge, some designers of ventilating systems neglect entirely the loss of pressure in the heating coils, assuming that it is so small as to be of no importance. Suppose this is done with a system in which the total pressure of the fan is only ½ oz. per sq. in. The loss of pressure in the heating coils might easily reach ¼ oz. per sq in., in which case only about one-half as much air would be delivered by the system as was intended. Neglect to allow for the loss of pressure in the heating coils explains why some ventilating systems are not giving satisfaction.

ARRANGEMENTS FOR TEST

Appreciating the need for more reliable data on the loss of pressure in heating coils, a series of tests were planned and carried out about a year ago with the object of securing definite information on this point. These

tests were conducted with a ventilating set consisting of a 48-in. steel plate fan run by a 10 H. P. electric motor, and a heater consisting of four two-row sections of 1-in. pipe spaced 2 in. center to center, which represents an ordinary type of heater. The coils were 6 ft. high and 5 ft. wide. The heater coils were encased in sheet iron, and were connected to the fan by a 40-in. circular galvanized iron pipe about 8 ft. long. The air was drawn through the heater coils, entering the fan at the center and discharging at the bottom into the ducts leading to the various rooms.

The general plan of the tests was to run the fan at a constant speed for each test, while the velocity of the air passing through the 40-in. pipe connecting the coils and fan was obtained with a Pitot tube, and, at the same time, the difference in pressure between various coils was measured with a manometer and tube. The above tests were made with different speeds of the fan, thus obtaining various velocities of air through the heater coils.

The motor used to run the fan was a direct-current shuntwound motor. It was connected with a rheostat in both field and armature, so it could be run at a predetermined and constant speed throughout any test. With a constant speed of the motor it was determined that the flow of air through the coils was constant.

The quantity of air passing through the 40-in. pipe, connecting the coils and fan, was measured at a point midway between the coils and fan. At this point the velocity of the air passing through the pipe was measured at 31 different points scattered over the cross-section of pipe. The average velocity of the air, multiplied by the cross-sectional area of the pipe, gave the number of cu. ft. passing per minute. The method of averaging the velocities is unique, and will be described later. The velocities were measured with the Pitot tube shown in Fig. 1, each branch being connected to a branch of a differential manometer. The difference in height of the liquid in the two branches of the manometer indicated the velocity.

HOLES BORED IN HEATER CASING TO OBTAIN PRESSURE

The loss of pressure in the heating coils was obtained by inserting

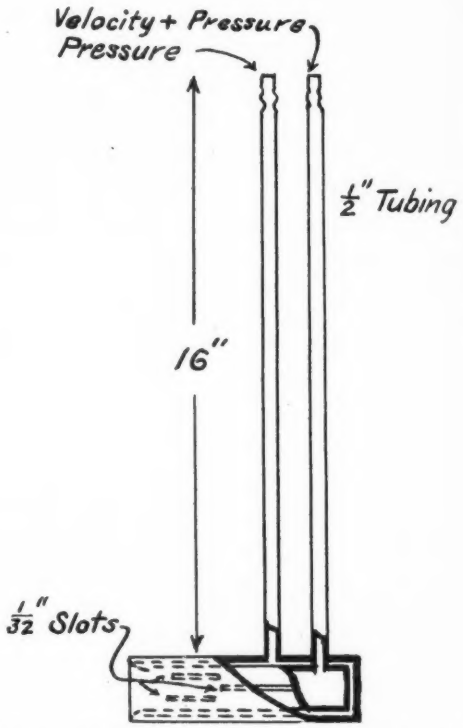


FIG. 1—ARRANGEMENT OF PITOT TUBE FOR MEASURING AIR VELOCITIES

through holes bored in the side of the casing, two brass tubes, 3/8-in. in diameter, having one end bent at right-angles, so it could be inserted between the pipes. The bent portion of these tubes had 1/32-in. holes in the sides, in such a position that when the tubes were inserted in the coils the holes came in line with the front of the row of pipes immediately preceding. The height of the casing was divided into six equal parts, and five rows of holes were bored through the side, midway of each part and extending across the casing, each row containing five holes. There was thus a row of holes for measuring the pressure between each of the four two-row sections, and one for measuring the pressure in front of the first row.

Eight readings of pressure were taken through each hole at spaced distances across the coils, thus obtaining

forty readings at each velocity and for each section. The average of these forty readings was taken as the average difference of pressure on the two sides of that particular coil. One tube remained in the first vertical row of holes, so as to measure the pressure in front of the entire set of coils, while the other tube could be moved back to include any number of sections, the two tubes being always in the same horizontal row when a reading was taken. By connecting each

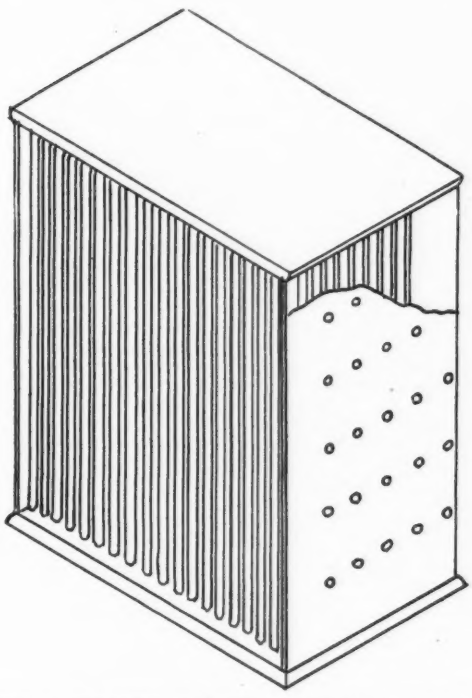


FIG. 2—HEATER CASING, SHOWING HOLES THROUGH WHICH PRESSURE IN COILS WAS MEASURED

of the tubes to one branch of the manometer, the difference in pressure could be read directly. Fig. 2 gives some idea of the arrangement of the holes. All holes in the casing, except the two which were being used, were stopped with corks.

Realizing that the difference in pressure, and, therefore, the difference in heights of the liquid in the manometer, would be very small, special differential manometers were constructed to secure greater accuracy. The same kind of manometer was used with both the pressure tubes and the Pitot tube. These manometers were made of ⅜-in. glass tubing, bent in the form of a U, and having an enlargement ⅞ in. in diameter at the top of each branch. The height of the glass U tube was 18 in., and it was mounted on a stout oak stand. A mirror was placed back of the U tube, being wide enough to extend under both branches, and a scale of inches and tenths was engraved with fine lines directly on the mirror. It could then be easily seen if the line of sight was directly in line with the meniscus of the liquid, thus obviating any error due to parallax, or the line of sight being above or below the meniscus. The liquids used in the manometers were, first, a mixture of two parts of toluene having a specific gravity of 0.866, and one part carbon titchloride, having a specific gravity of 1.63. This mixture, having a specific gravity of 1.12, was placed in the bottom of the manometer, and distilled water placed in the top. This gave a very clear and easily read meniscus, and it was found that a manometer constructed in this way multiplied the pressures about five times, giving great accuracy to the readings. The manometers were calibrated several times each day, to determine whether there was any change with age. It was found that after one week there was hardly any appreciable change.

Having determined the difference in pressure between the two sides of a heater section by the method described above, the corresponding velocity of the air through the heater was determined by dividing the number of cu. ft. of air passing through the heater per minute by the clear area of the heater. The clear area was obtained by subtracting from the total area of the heater the area occupied by a single row of pipes.

Ordinarily it might be expected that the velocity of air passing through a cross-section of the pipe connecting the heater with the fan would vary uniformly from the circumference towards the center, and that the point of maximum velocity would lie in the center of the pipe. It was found, however, upon exploring a cross-sec-

tion of the pipe about midway between the fan and the heater, that the velocity over a cross-section varied in a very erratic manner, there being an area of maximum velocity near one side of the pipe, and below the center. This was probably due to the position of the fan outlet, which was at the bottom, and discharging toward the side on which the area of maximum velocity lay. Since the velocity was so variable over a cross-section, it would be impossible to find the average velocity by simply measuring the velocity at different points, and averaging them according to their position.

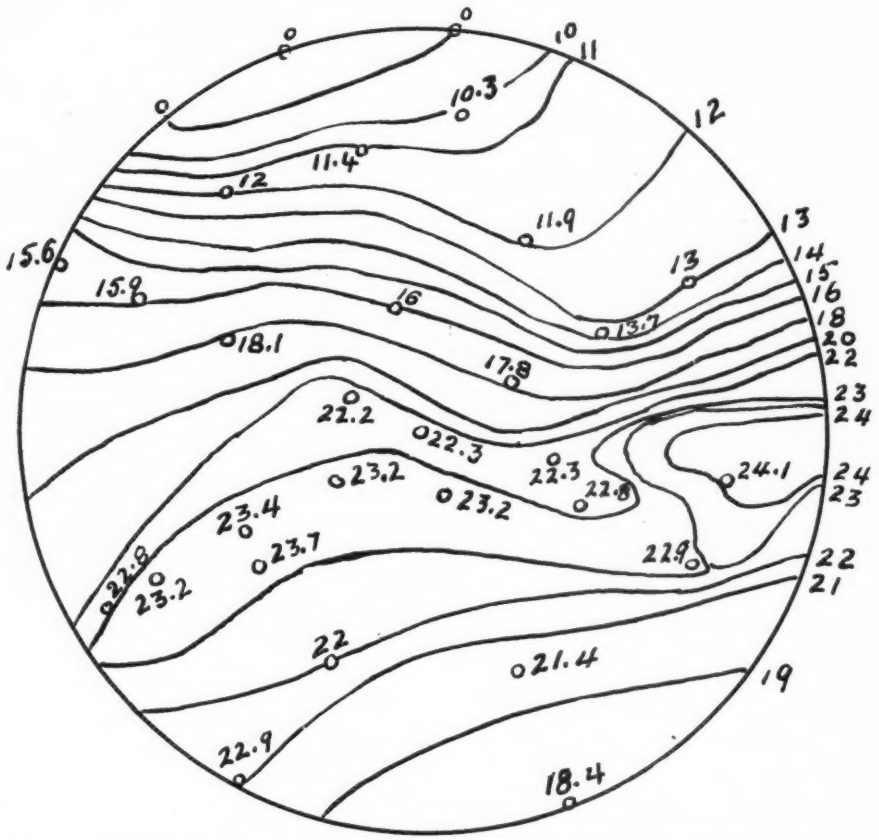


FIG. 3—THIRTY-ONE READINGS OF VELOCITY OF AIR PASSING THROUGH A CROSS-SECTION OF PIPE CONNECTING HEATER WITH FAN

METHOD OF OBTAINING AVERAGE AIR VELOCITY THROUGH PIPE

In order to obtain the true average velocity, a series of 31 readings of velocity was obtained, while the speed of the fan remained constant, scattered over the entire cross-section. The location of the points at which these velocities were taken was then plotted on a drawing of the cross-section of the pipe, drawn to scale, as shown in Fig. 3. Lines were then drawn through all points having the same velocity, and midway between these lines of equal pressures or contours, other lines not shown in the figure were drawn, which inclosed areas in which the velocities could be considered as being the same as the contour lines through these areas. Then the sum of the products of these areas times the velocity in each, when divided by the total areas, will give the most probable true average velocity through the section. This was the method of obtaining the velocity of the air passing through the pipes, and from it the quantity passing. It was found in one case that the true average velocity, as calculated above, was

LOSS OF PRESSURE IN BLOWING AIR THROUGH HEATER COILS, AS DETERMINED BY TESTS

Velocity of Air through clear area Feet per Minute	Pressure Loss, ounces per square inch			
	Number of 2-row Sections			
	1	2	3	4
586	0.0057	0.0121	0.0169	0.0243
760	0.0099	0.0190	0.0232	0.0378
930	0.0145	0.0296	0.0394	0.0562
1000	0.0169	0.0332	0.0459	0.0640
1180	0.218	0.0441	0.0630	0.0910
1200	0.0244	0.0465	0.0725	0.0930
1280	0.0260	0.0545	0.0795	0.1050

926 ft. per minute, while, if calculated by simply averaging each velocity according to its position, the result would have shown a velocity of 1159 ft. per minute, which would have been an error of over 25%.

RESULTS OF TESTS

The results of the tests conducted, as outlined above, are shown in the following table, and are plotted in the form of curves in Fig. 4, for easier reference:

FORMULA FOR LOSS OF PRESSURE

From the results of these tests, as plotted in Fig. 4, it is seen that the pressure loss varies directly as the

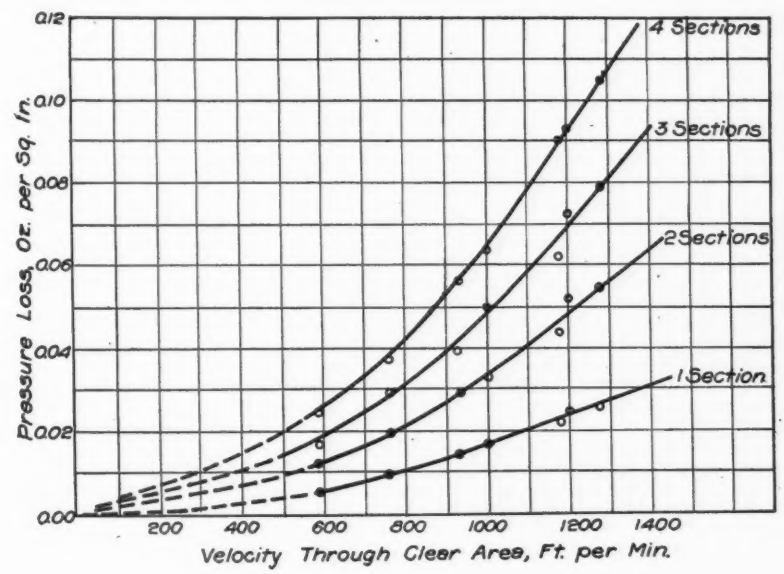


FIG. 4—RESULTS OF TESTS FOR LOSS OF PRESSURE IN BLOWING AIR THROUGH HEATER COILS

number of sections of heating coils, and also, approximately, as the square of the velocity of the air passing through the free area. The general form of equation for these curves is

$$y = mx^b \qquad (1)$$

Changing this to the logarithmic form gives

$$\log y = \log m + b \log x$$

The logarithmic values were plotted in order to find the values of m and b in equation 1, the equation giving a straight line with m as the intercept on the vertical axis, and b as the slope. This showed that for a two-row section the value of m was 0.0000000157 and varying directly with the number of two-row sections. Changing the equation back to its original form gives

$$p = 0.0000000157\ n\ v^2$$

in which p is the pressure loss in the coils expressed in ounces per sq. in.,

n is the number of two-row sections in the heater, and

v is the velocity of the air through the clear area, in ft. per minute.

From the above equation, the loss of pressure in blowing air through standard heater coils can be calculated if the quantities n and v are known or assumed. The results confirm what had long been suspected—namely, that if the loss of pressure in the heater coils is neglected in designing ventilating systems, the amount of air delivered by the system will fall far short of what is expected.

Great credit is due to Mr. N. J. Kayser, who took the data for these tests, for the painstaking care with which the work was done.

Heating Arrangements for an Extensive Group of Factory Buildings

The plant of the United Shoe Machinery Company at Beverly, Mass., for the manufacture of boot and shoe machinery, is the first factory constructed entirely of reinforced concrete, and stands to-day as the most extensive example of the use of this form of construction for machine-shop purposes in the country. The present floor area aggregates 600,000 sq. ft., and when the addition now being erected is completed the total floor space will be 744,000 sq. ft., or more than 17 acres.

The construction and arrangement of this plant was made the subject of an elaborate paper by L. P. Alvord, New York, and H. C. Farrell, Beverly, Mass., read before the American Society of Mechanical Engineers. The main buildings, originally 520 ft. long, are now 820 ft. Fig. 1 shows an outline plan of the buildings as they will be after the present additions are completed.

All of the buildings are connected by pipe and cable tunnels (Fig. 1), which enter underground chambers containing fans and heater coils for the indirect heating systems. Fig. 2 is a typical cross-section of the tunnel entering building A B X. The walls are used for piping, and beneath the floor are vitrified conduits for the electric cables. The floor of this tunnel pitches upward from the power house, and a gutter at one side receives any moisture that may enter any conveys it to a pump in the power-house basement, from whence it is pumped to waste.

The method of supporting the pipes in this tunnel was to bolt 6-in. by 8-in. hard pine posts to the inner walls. To the outer faces of these posts the pipe hangers are fastened by lag screws. These posts are spaced 10 ft. on centers,

The modifications of this tunnel over those originally planned consisted in increasing both the width and height in order to give more room to facilitate changes and repairs and in the use of hard pine posts instead of cast-iron slotted supports for the pipe brackets. The width of the original tunnel was 5 ft. in the clear; the new one 7 ft., and an average height of 7 ft.

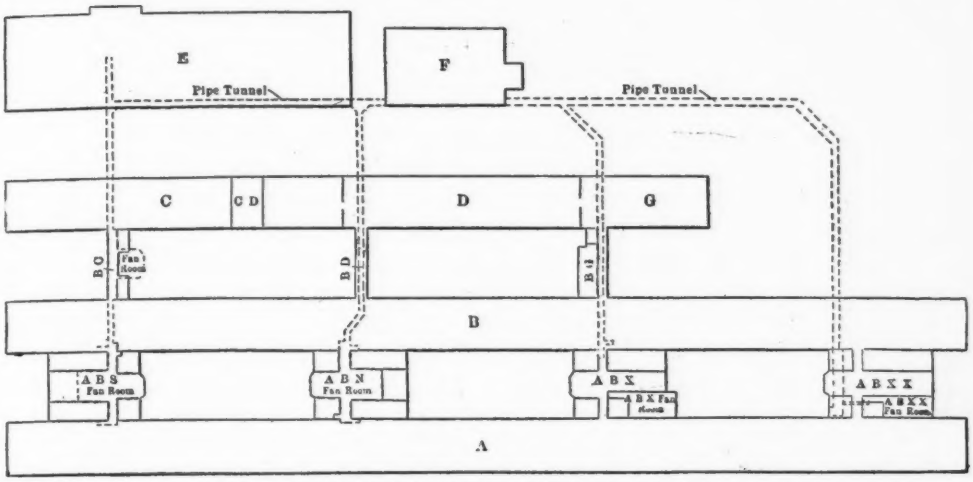


FIG. 1—PLAN OF UNITED SHOE MACHINERY COMPANY'S PLANT AT BEVERLY, MASS., AS IT WILL APPEAR WHEN PRESENT ADDITIONS ARE COMPLETED

At points just within the walls of buildings A and B (Fig. 1) will be noticed short connections from the tunnels which serve as a point from which pipe risers are conducted vertically upward through the buildings.

HEATING OF MAIN BUILDINGS

Fig. 1 also shows the underground fan chambers in each one of the main toilet-room wings. These chambers contain the heating engines, fans and coils for furnishing heat to the main machine-shop buildings, and storage building C. In the original plant 7990 sq. ft. of radiating surface is provided for each of the machine-shop buildings, or 1 sq. ft. of radiating surface for each 218 cu. ft. of room volume.

In this installation the ducts from the fans were carried outside of the buildings and connected underground to openings in the pilasters having the heating flues, by means of a flexible connection. The fan chambers under wings ABS and ABN contain, in addition to the fans for heating the main machine shops, fans for heating the toilet-room wings themselves.

In the older part of the plant it was difficult to maintain a suitable temperature at the north ends of the machine-shop buildings in severe winter weather. For this reason, the heating factor in the 1906-1907 addition was made 1 sq. ft. of radiating surface for every 130 cu. ft. of room volume. A certain amount of this increase was intended to provide for the lack of heating capacity in the older part of the plant.

Another change consisted in bringing the hot-air ducts within the building line, placing them close against the outer wall and making this roof a part of the ground floor slab. This has the beneficial effect of tending to increase the temperature of the ground floor itself.

The heating plants for the toilet-room wing ABX were omitted and direct radiation by wall coils substituted. Experience has demonstrated that all of these modifications were wise, and in the addition now under way the heating arrangements of the addition of 1906-1907 will be duplicated.

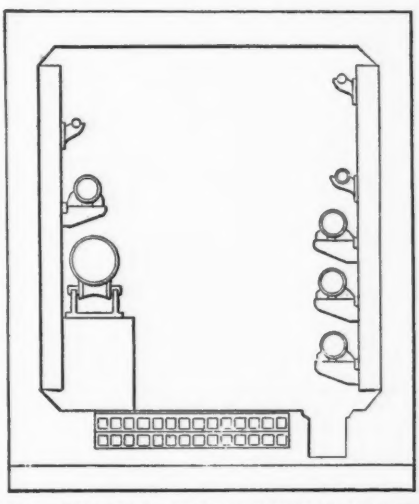
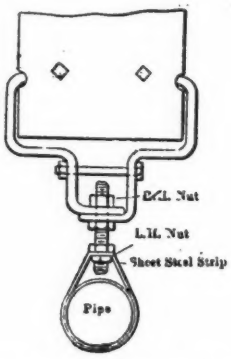


FIG. 2—TYPICAL CROSS-SECTION OF PIPE AND CABLE TUNNEL

Because of the large window area, no provision was made for mechanical ventilation in the main buildings, except that in extremely hot weather the heating fans are run to supply fresh, outside air through the heating system.



ELECTRIC WIRE SUPPORT AND PIPE HANGER

TOILET-ROOM WINGS

The toilet-room wings, designated in Fig. 1 by the letters ABS, ABN, ABX and ABXX contain locker rooms, wash rooms, toilet rooms, tool storage and delivery rooms, stair wells, and, as mentioned before, the connecting passageways between the main buildings.

All of the rooms are provided with mechanical ventilation, through a system of ducts in the walls leading to a chamber under the roof containing a direct-connected ventilating fan discharging to the outside air.

In the original building there was no local ventilation for the toilet-room utilities themselves, but it was provided in the additions. The improvement in conditions has been marked.

Two New Hot Blast Formulas

A typical instance of the advantages enjoyed by manufacturers of heating goods over those in the designing end of the business for procuring new and reliable information on engineering subjects is to be seen in the interesting data lately compiled by the Green Fuel Economizer Co., Matteawan, N. Y. The generosity with which the data are placed at the disposal of the public is not the least noteworthy feature of this company's latest production.

LOSS OF HEAD BY FRICTION OF AIR IN PIPES

On the subject of the loss of head by friction of air in pipes, which is one of the subjects treated in the book in question, which is entitled "Heating and Ventilation," the writer states:

Friction or resistance to the flow of air through a flue or conduit can be expressed as a negative head to be subtracted from the total head possessed by the air before passage through the pipe. The head lost in friction varies with the velocity, the roughness of the enclosing surface, curvature of the channel and the form of the cross-section; it also depends upon the viscosity, which varies with the temperature. Moreover, the drop in head follows at high velocities a law different from that holding for low velocities—that is, below the so-called critical velocity the drop is proportional to the velocity, while above the critical velocity it becomes proportional to the square of the velocity.

In flues of ordinary cross-section and with the velocities common in fan practice, the flow is turbulent—that is, above the critical velocity. For this condition the following expression for loss of head due to frictional resistance may be used—namely,

$$H_r = \frac{U^2\ YLZ}{2g\ Q}$$

in which H_r is head in feet of air, U is the velocity in feet per second, g the acceleration of gravity, $(= 32.17)$, Y a coefficient of friction, L the length of the pipe in feet, Z the perimeter of the pipe in feet, and Q the cross-section in square feet. Values of Y are given on the accompanying chart.

This gives the head lost in friction only and is not to be confused with the total loss of head required to force air through the pipe, since the head

required to give the fluid velocity through the pipe is ordinarily included in the latter. Also, it applies only to straight parts of the flue. Bends and obstructions in the pipe will cause additional losses of head.

$H_h = \frac{U^2}{2g}(b_1 + b_2 + \text{etc.})$, wherein

b equals 1.1 for right-angled sharp corners,

0.3 for sharp angles of 135°,

0.25 for a right-angled bend of which the radius is equal to the diameter of the pipe,

0.15 for a right-angled bend of which the radius is 2 to 4 times the diameter of the pipe,

0.07 for a right-angled bend of which the radius is 5 to 6 times the diameter of the pipe,

Zero for bends of which the radius is more than 6 times the diameter of the pipe,

0.15 for a branch turning off at 135°,

1.5 for a grill or register of which the free area is one-half the total area and the free area is equal to the cross-section of the pipe line,

0.75 when the area of the register is 1½ times the cross-section of the pipe.

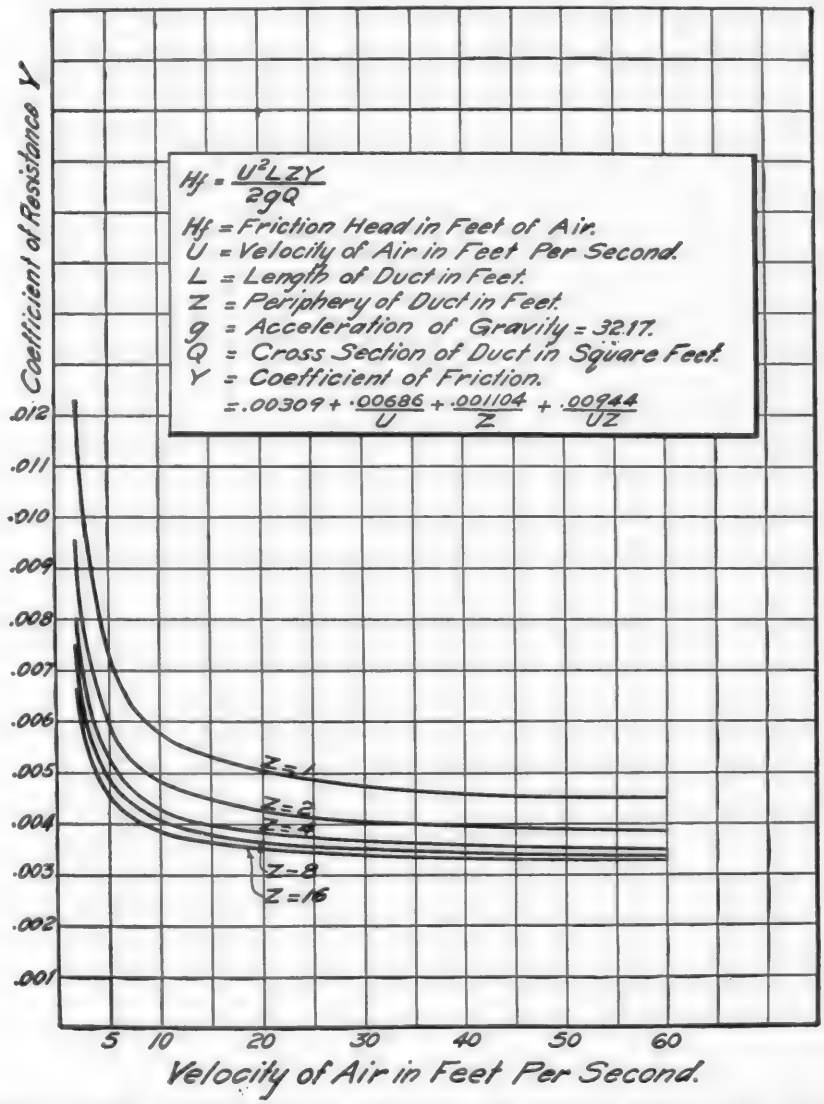


CHART GIVING COEFFICIENT OF FRICTION FOR SMOOTH SHEET IRON PIPES

When the free area of the grill or register is 0.2 that of the total grill, $b = 2$ when the free area is equal to the area of the flue and 1.0 when it is equal to 1½ times the area of the flue.

For sudden changes in the cross-section of the flue, $b = \left[\frac{Q_1}{Q_2} - 1\right]^2$ in which Q_1 is the cross-section of the large pipe and Q_2 the cross-section of the small pipe, and b is used in connection with the velocity in the large pipe.

LOSS OF HEAD THROUGH ORIFICES AND EQUIVALENT ORIFICES

Since the head required to produce a given flow, S, of air through an orifice increases as the square of the flow, and since the head required to overcome the friction of bends, contractions and other obstructions in the air circuit also increases as the square of the flow, we may write the equation of the complete circuit as follows:

$$H = R\,S^2$$

wherein H is the total head required to force the volume S in cu. ft. per second through a circuit of which the total resistance is R. If R be expressed in appropriate units, 1 ft. head of air will produce a flow of 1 cu. ft. of air per second, through 1 unit of resistance.

Experiments made by W. N. Shaw indicate that such a unit or standard resistance would be that of an orifice in a thin plate of area a, where $a^2 = 1/27$ or $a = 0.189$ sq. ft. If the aperture is circular and of diameter d, then $\frac{\pi d^2}{4} = 0.189$, or $d = 0.498$ ft. In other words, a circular aperture of a diameter of about 6 in. will have unit resistance according to the above definition. Since the head consumed by resistance increases as the square of the velocity of flow, it will further appear that the resistance of an orifice varies inversely as the square of the area of the orifice.

When different resistances are passed in series by the current of air, the total resistance of the circuit is the sum of the pneumatic resistances of the several parts arranged in series. For instance, suppose a room to have on one side an inlet orifice 6 in. in diameter and on the opposite side an outlet orifice 1 ft. in diameter. The resistance of the inlet orifice, according to the above definition, will be 1. The area of the outlet orifice is four times as great as that of the inlet orifice, and the resistance will therefore be 1/16 and the total resistance encountered in forcing the air into and out of the room will be 1 1/16.

If air flows from one point to another by two different paths simultaneously, the drop in head over each path will be the same. If the resistance of the two paths are R_1 and R_2 respectively, we will have the equations

$$H = R_1\,S_1^2$$
$$H = R_2\,S \quad \text{and}$$

also if the total flow is S we will have

$$H = R\,S^2$$

where R is the resistance equivalent to the combined resistances of the two circuits in parallel.

From these three equations we may easily deduce, since $S = S_1 + S_2$, the following:

$$\frac{1}{\sqrt{R}} = \frac{1}{\sqrt{R_1}} + \frac{1}{\sqrt{R_2}}$$

Then if we substitute for R, R_1 and R_2 their equivalents—namely,

$$\frac{1}{27\,a^2}, \quad \frac{1}{27\,a_1^2} \quad \text{and} \quad \frac{1}{27\,a_2^2},$$

where a, a_1 and a_2 are the respective areas of the equivalent orifices we have, $a = a_1 + a_2$, or, in words, the combined air passing capacity of orifices or channels in parallel is the same as that of a single channel whose equivalent thin plate orifice is equivalent in area to the sum of the areas of the equivalent thin plate orifices for the separate channels.

We may, therefore, speak of the thin plate orifice equivalent to the resistance of a mine, although the mine may contain many passages in parallel and series. Or we may speak of the equivalent orifice of a duct or of a complex ventilating system, or the equivalent orifice corresponding to the grates, the fuel on the grates, the

boiler passages and the chimney of a steam boiler plant. Or, if we know the equivalent orifices of the several parts which are arranged in series and in parallel, we can easily calculate the equivalent orifice of the whole.

Before leaving this subject, it will be well to point out just what the unit of equivalent orifice is. Shaw's experiments are based on the use of a circular orifice in a thin plate, and a comparison of his formula

$$H = \frac{1}{27\,a^2} \times S^2,$$

with the formula for falling bodies

$$U^2 = 2g\,H,$$

wherein g = acceleration of gravity and U = velocity in ft. per sec., will show that the coefficient of this thin plate orifice works out as 0.653. That is, only 65.3% as much air is passed through the orifice as would be passed if the whole orifice were occupied by a stream moving with the velocity U theoretically due to the head H. Orifices of different shapes and with different conditions of approach or efflux, have different coefficients. For instance, if the up-stream side of the flat plate is roughened, as by pasting sand paper on it, the coefficient will be increased—that is, more air will flow through under a given head. On the other hand, if the up-stream side be provided with a raised edge the coefficient will be reduced to about 0.5. If the collar is on the discharge side, however, and is extended to form in effect a long pipe, the coefficient will be increased to a value approaching 0.83.

Heating and Ventilating Concrete Buildings

Scarcely anything could be imagined that would be more likely to bring about the desired intimate association of the architect with the heating and ventilating engineer than an increased adoption of ferro-concrete in the construction of large buildings.

It has been pointed out that reinforced concrete building restricts the "air leakage" which is usual when other materials are employed. On the other hand, heat transmission through ferro-concrete walls is more rapid than through brick walls, partly owing to the better heat conductivity of the material, but more to the decreased thickness of the walls.

Let it be taken for granted, as we may reasonably do, that a public demand for ferro-concrete construction will certainly, if slowly, extend; then it will be seen that numerous advantages fall to the engineer—relatively small in themselves, perhaps, but possessing a cumulative value that will have an important bearing on the two essentials already stated, of the unrestricted acceptance, and full efficiency in subsequent working, of the engineering installation.

In the first place, very careful and complete architectural consideration must be paid to the heating and ventilating scheme along with the preparation of the plans. Flues and ducts cannot be concealed in thin ferro-concrete walls. Floors and walls must be planned for their admission beforehand, to avoid any considerable cutting through the hard concrete, with its vitally important arrangement of the reinforcement. In view of the fact that there will be no "roof space" in large concrete buildings, as is required by some heating and ventilating schemes, definite architectural provision must be made for running the pipes. There will also occur at times a practical difficulty in conveying the vertical pipes and flues, when, as in steel-frame buildings, division walls are not continued up and down from floor to floor. At almost every turn it will be found that need will arise for close collaboration between the architect and the engineer—a necessity which must tend materially to the soundness and completeness of the engineering scheme, making it, in fact, a recognized integral part of the entire architectural conception.

Then there will also be advantages in the direction of reducing the cost of the installation. Economy will be

further increased by forming the ducts entirely of reinforced concrete—that is to say, doing away with all brickwork, making the ducts practically air-tight, and so minimizing the heat losses in transit—a reduction which will be furthered by the formation of proper curves and angles which have not been easily possible in brickwork. Concrete ducts will also be cheaper to construct, and this fact should induce architects to view them with greater leniency than formerly.

A further advantage to the engineer will be found in the method of laying the floors as the work proceeds, instead of waiting for the building frame to be first completed. These are typical instances of the changes involved in the adoption of reinforced concrete in main buildings. In many minor respects, further advantages, all tending both to economy and to efficiency, will be found in the adoption of the new medium for the construction of such matters as chimney stacks, water storage tanks, "sumps," foundations for machinery, air inlet and outlet shafts, etc.

As ferro-concrete tends to more rapid construction than brickwork, and much more rapid than stonework, the consequent saving in first cost is allied to the many other advantages already recognized. The disadvantages, chiefly of an æsthetic nature, architects will be called upon to overcome. Its widespread adoption is but a question of time. Engineers have already to reckon with it very seriously. Heating operations will be facilitated by it; but the many complex questions that already arise on every "job" will, in all probability, be further complicated by a new and at present unknown factor.

An impervious material, such as this has not yet been fully dealt with scientifically in its relation to health-giving air inclosed by it. At this point the ventilating engineer is called upon with no little urgency. That he will rise to the opportunity none will doubt who has followed him from stage to stage in the last twenty years' expansion of his business.—*F. G. Stevens.*

Do Gas Lights Contaminate Air?

Following closely upon the doubts expressed as to the value of the carbon dioxide test for determining the purity of air, the statement is now made that gas lighting, so far from having a deleterious effect upon the air in a room, has a positively beneficial effect upon such air in adding to its hygienic value. Just how this is accomplished is explained by R. F. Pierce, in *The Illuminating Engineer.* One of the greatest advantages of gas lighting, he states, and one that strangely enough has received little or no attention, is the highly beneficial effect upon the quality of the air in illuminated interiors. As this effect is not at all obvious, but, on the contrary, the reverse would, upon casual consideration, appear to be true, it is highly desirable that the facts in the case be set forth in such a manner as to admit of the rational comparison of different illuminants in this respect.

Many people carelessly and unthinkingly assume that because the burning of a gas light discharges products of combustion into the room, a perceptible vitiation of the atmosphere must result. As a matter of fact, the precise reverse is the case, and this fact really constitutes one of the greatest advantages to gas over electricity for illuminating purposes.

The combustion of gas produces, from a chemical standpoint, four different effects upon the air taken from the room, mixed with the gas in the burner and discharged back into the room.

These effects are:

First.—The amount of oxygen is reduced.

Second.—The amount of carbonic acid gas (CO_2) is increased.

Third.—A very small amount of sulphurous gas (SO_2) is generally added.

Fourth.—Organic impurities and

deleterious substances are removed by incineration.

The first, second and third effects are caused by the oxygen combining with the carbon and sulphur contained in the gas, and this oxidizing process generates heat in sufficient quantities to raise the mantle to the temperature of incandescence—about 1500° F., which is sufficient to produce the fourth effect.

The physical effects produced upon the air are:

First. — The temperature is increased.

Second.—The circulation of the air in the room is accelerated and the ventilation from the outside is increased.

As the quality of the air in the room at any time depends upon the interaction of the incoming fresh air upon the products of combustion discharged from the burners and the organic matter exhaled from the lungs and skin of the inhabitants of the room, it is necessary to investigate the inter-effects of all three.

On account of the tendency of heated air to expand, become lighter and rise, the presence of any source of heat in a room produces a certain circulation of the air, which serves a double purpose. In the first place, the heated air is cooled by contact with successive portions of the relatively cool walls, and in the second place the temperature in the upper portions of the room tends to increase, while that in the lower portion tends to decrease below that which would prevail without circulation. This produces an unbalanced pressure from the outside, tending to draw fresh air in at the bottom of the room through crevices, joints and other openings, and also to a greater extent than is ordinarily realized through the walls themselves. The same action tends to expel the air in the upper portion of the room in the same manner, and this tendency is, of course, greatly augmented by increased facilities for ventilation.

As a gas lamp produces about six times as much heat as a Magda or tungsten lamp of equal illuminating power, it follows that the ventilating effect is correspondingly greater. At first thought it might appear that the use of gas lamps for ventilating purposes would be very inefficient, and that their effect would be practically negligible.

While positive assurance derived from actual installations is submitted later on, it may be well to call attention at this point to the fact that in many chemical laboratories, where the air is being constantly vitiated by noxious vapors, the principal means of exhausting the contaminated air is through the use of an open gas jet placed in a suitable vent. The ventilation produced must, of course, be far more effective than that required for any ordinary purpose, as the contamination of the air is exceptionally rapid.

Of course, in making use of the ventilating properties of gas burners, a balance must be struck between the amount of radiant heat generated and rapidity of ventilation. It does not follow that the foulness of the air is always decreased by increasing the amount of heat generated in the room. This is, of course, perfectly obvious. The writer only purposes showing that under the conditions usually met in lighting practice the substitution of gas for electric lighting will generally produce this effect—other conditions being equal.

In considering the concurrent effects of light sources and the incoming air upon the average quality of the interior air at any moment, it is necessary to inquire into the nature and effects of the vitiating substances. Generally speaking, these are divided into two classes: Those emitted by the respiration, both from the lungs and the skin of the people in the room; second, those emitted by the illuminants. The first class includes germs of those diseases which are transmitted by germs, which, when taken from the air into the system through the mouth or skin, will produce their characteristic diseases. As a matter of fact, the supposedly fresh air from the exterior is often heavily laden with germs of this character.

More commonly than any other are felt the effects of the vitiation pro-

duced by the organic matter in a greater or less advanced stage of decay exhaled by the lungs. This produces the stuffiness in a poorly ventilated room which is sometimes ignorantly attributed to carbonic acid gas.

As between gas and electric lighting, the former is the only one contributing any products of combustion whatever, and these are as follows: First, carbonic acid gas; second, sulphurous acid gas; third, water.

On account of the ability of gases to diffuse through even the tightest walls used in building construction, the proportion of carbonic acid gas in interiors rarely rises above 20 parts in 10,000, though for experimental purposes this proportion has been made as high as 50 parts in 10,000. This was accomplished only by resorting to exceptional means to secure a high percentage of this gas. Thus, practically speaking, it may be said that it is impossible in practice to obtain enough carbonic acid gas in an ordinary room to produce the slightest effect upon the bodily functions, even when the most sensitive tests are employed to detect such effects.

Sulphurous acid gas, when present, is in such almost infinitesimal quantities that it is disregarded by investigators, as far as effects on the health are concerned, though unscrupulous or ignorant salesmen of lighting apparatus frequently attempt to make capital of it. While it is in the quantities found entirely harmless to the human organism, it has a decided sterilizing effect as regards disease germs, which will be referred to later.

While it is true that carbonic acid gas artificially produced—that is, by gas combustion—is entirely innocuous in any quantity met with in human habitations, it must not be assumed that such quantities of this gas exhaled from the lungs may be regarded as an indication of sanitary conditions. On the contrary, even 15 parts of carbonic acid gas in 10,000, if arising from respiration of human beings, indicates the presence of organic matter in such quantities as to be highly obnoxious or even harmful.

In this connection it should be noted that the vitiation of air by human beings is generally expressed as percentage of carbonic acid gas, because it indicates the amount of organic matter which has been given off in the same period; and while the latter (which is the real source of pollution) is difficult to measure, the carbonic acid gas is easily determined.

From a sanitary standpoint, therefore, figures regarding the quantities in which carbonic acid gas indicates harmful conditions apply only to this gas when thrown off by the lungs, and not to the same gas produced by artificial means, such as the operation of gas lights.

It is evident that the absurd practice of rating each gas burner as equal to a certain number of human beings in vitiating the air in interiors is not only highly ridiculous, but precisely opposite to the dictates of common sense and the testimony of established facts; for, as will be shown later, the presence of gas burners actually removes the vitiating matter.

In order to substantiate the statements made above, the following extracts from the reports of competent authorities and experimenters are submitted.

TESTS WITH GAS AND ELECTRIC LIGHTS

Probably the most extensive, painstaking and intelligent reports upon the relative hygienic value of gas and electric lighting were those made by Samuel Rideal, D.Sc., F.I.C., a report of which was contributed to the *Journal of the Royal Sanitary Institute,* published in Vol. XXIX, No. 2.

This investigation was carried over a considerable period of time in a room provided with both gas and electric lights, the former from inverted incandescent burners and the latter from incandescent electric lamps.

These experiments were made in an office building at No. 28 Victoria street, London, in a room 29 ft. 9 in. x 16 ft. 4½ in. x 10 ft. 4 in., and covered a considerable period of time. Exceptional pains were taken to see that the inmates of the room were all healthy and could be classed as fair physiological examples of men living and working in London, and every

care was taken to exclude those affected with transient catarrhal or other symptoms likely to affect the results of the experiment.

The experiments covered a wide range of conditions, and the tests included frequency and character of pulse, as shown by the sphygmograph, frequency of respiration, arterial blood pressures, variation in the number of blood corpuscles, body temperatures, body weight, mental fatigue, time reaction, etc. The physical and chemical determinations included the change in temperatures, due to the different illuminants, rapidity of ventilation, content of carbonic acid gas, number of bacteria, amount of organic matter, relative humidity, etc. The amount of gas consumed and its calorific value was carefully determined, as well as the input of the electric lamps. The illuminating power of the gas burners was considerably in excess of that of the electric burners, as was determined by photometric test.

The report comprises over 80 pages, and in the limited space available here it is obviously impossible to reproduce the data with sufficient entirety for the reader to criticize or analyze it satisfactorily. The following extracts from the summaries of this investigation are given herewith.

An accompanying table gives a summary of the average temperatures at the beginning and end of the runs.

The results of these tests show plainly that the difference between gas and electric light on the temperature of the room was negligible.

TABLE SHOWING EFFECT UPON ROOM TEMPERATURES OF GAS AND ELECTRIC LIGHTS

	Gas				Electric			
	No. of	Degrees F.			No. of	Degrees F.		
Arrangement	runs	Initial	Final	Rise	runs	Initial	Final	Rise
Restricted ventilation:								
*Undivided room	22	53.6	57.0	3.4	18	54.0	57.2	3.2
Divided room	6	59.0	63.4	4.4	6	58.7	62.9	4.2
Fireplaces and ventilators open:								
Divided room	2	60.8	63.9	3.1	2	59.2	62.7	3.5
Fireplaces, ventilators, doors and windows open:								
Divided room	2	58.4	57.5	—0.9	2	58.3	56.9	—1.4

*During the series of experiments, the room was divided into two equal and symmetrical parts by a wooden partition in a number of the tests.

As regards the presence of organic matter in the air, the figures below are expressed in volumes of oxygen consumed per million volumes of air for the oxidation of the organic matter.

Thus the increase under electric lighting during the day in the undivided room was about 50% greater than that under gas light. In the undivided room the increase under electric light over gas light was somewhat greater.

As regards the bacterial contents of the room, Dr. Rideal stated that the following factors would all tend toward lessening the bacterial content with gas lighting as against electricity:

First.—The cremation of organisms in the flames.

Second.—The sterilizing effect of the sulphur acids in the gas.

Third.—The increased condensation on the cold surfaces, removing organisms as well as the sulphur products.

RESULTS OF TESTS FOR PRESENCE OF ORGANIC MATTER IN THE AIR

		Room		
	Air Outside	5:45 p. m.	9:00 p. m.	Rise
Undivided room:				
Average total	2.8	4.9	8.8	....
Average total gas	...	5.3	9.0	3.7
Average total electric	...	4.0	9.8	5.8
Divided room:				
Gas	...	...	...	2.7
Electricity	...	...	...	4.7

Fourth.—Any increased ventilation of the room.

The organisms falling by gravity and air currents were determined by the exposure of nutrient gelatine plates for a definite time in various positions in the rooms, and a reduction of 29.2 was obtained under electric light, as against 35.3 under gas light. Obviously, in this test the ventilation was a most important factor, as these organisms were for a great part deposited upon the plates before having an opportunity of passing through the flames of the gas burner.

Another test was made of the organisms per cubic centimeter in the condensed moisture. The following table sets forth the results of this test, showing that while the sterilization of the air passing through the gas burner was entirely complete, no sterilizing action existed under electric light:

ORGANISMS PER CUBIC CENTIMETER IN CONDENSED WATER

Electric Light

Date 1907	Start	Finish	Persons in room
February 6.....	12	15	8
February 18.....	26	18	8
February 26.....	..	9	1

Gas Light

Date 1907	Start	Finish	Persons in room
February 11.....	4	.....	8
February 15.....	6	.....	9
February 27.....	..	.....	4

It may be well to call attention to the fact that at this point the condensed moisture carried but a small percentage of the bacterial organisms into the air, and while the entire absence of such organisms in the condensation under gas light would indicate a very complete sterilization of the air, it by no means follows that the number of organisms present in the water condensed under electric light give a very satisfactory indication of the number of organisms existing in the air, as only a small portion of the bacteria would be found in the condensed water.

As regards the ventilating effect, it was found that the percentage of carbonic acid gas was practically the same for both gas and electricity, showing that the gas burners have sufficient power to produce a ventilation adequate to remove the excess of carbonic acid gas produced. With ordinary ventilation the excess disappeared entirely, while with the poorest ventilation the slight excess of carbonic acid gas under gas light was practically negligible.

CO_2 PARTS IN 10,000 DURING STEADY STAGE

Divided room	Gas	Electric
Fireplaces and ventilators closed.....	41.1	31.1
Fireplaces and ventilators open.....	19.4	19.3
Fireplaces, ventilators, doors and windows open..	8.7	7.2

In the general summary, Dr. Rideal stated that gas burners give rise to stronger air currents and invariably produce a more active ventilation and diffusion of air than electric lights; hence, along with the products of the gas burner, the exhalations of the persons present were more rapidly removed. Second, the ascending currents of air from the gas lights on reaching the ceilings rapidly parted with their heat, which was conducted away by the rafters and joists. Third, the electric lamps produced more heat than is commonly accredited to them, and that this is the explanation of the unexpected result that the average temperature of the room was practically the same under either illuminant, and the electric light did not show the superiority in coolness usually claimed.

While the careful and exhaustive tests of Dr. Rideal would appear to be most convincing as regards the absence of the obnoxious products sometimes ignorantly attributed to gas burners, it may be worth while to note, for the benefit of the ultra-skeptical, that nearly all competent authorities agree that even if the CO_2 contents of the air were increased (which is not the case) such increase could not produce ill effects.

Dr. Angus Smith shut himself in an air-tight chamber with a lighted candle and remained until the candle was extinguished by the high CO_2 content produced (229 parts in 10,000). He felt no ill effects.

Dr. Richardson removed all the CO_2 from air that had once been breathed, and found that animals introduced into such air dwindled away rapidly and died.

Pettenkofer found that 100 parts of CO_2 in 10,000 parts of air was not injurious to human beings, while one-tenth the amount of CO_2 derived from lung and skin exhalations rendered the air unfit for human habitation for any length of time.

It would seem, therefore, that the scare of increased CO_2 content from gas burners may not only be said to exist only in the imaginations of interested exploiters of competitive illuminants, but, furthermore, if it did exist, would be perfectly harmless.

Review of Heating Literature

EDITOR'S NOTE—*A constant demand for back numbers of* THE HEATING AND VENTILATING MAGAZINE *which were long since out of print has led the publishers to feel that the reproduction of some of the more important matter appearing in these numbers would be welcomed by all our readers. Accordingly, we have arranged to publish under this heading a few of the more noteworthy articles which are no longer obtainable in the issues that contained them.*

I—GREENHOUSE HEATING CHARTS

BY JOHN A. PAYNE

The charts herewith presented were made to meet the average conditions found in connection with greenhouse heating with the outside temperature at zero, and have been found reliable in actual practice. They are intended to be used for houses having an eave line up to about 6 to 7 ft.

In the case of specially well built houses the amount of surface may be reduced about 7%. Where the cubical contents of the greenhouse are large in comparison with the glass surface the amount of surface given in the charts may be correspondingly reduced. It is safe to say that for a house of 25 ft. wide and 75 ft. long, with the eaves 10 to 12 ft. high, the surface specified in the charts may be reduced fully 10%.

The amount of surface given in the charts is based upon the assumption that the water in the pipes will have an average temperature of 150° F. If this temperature is increased to 160° the amount of surface may be decreased 10%. If it is increased to 170°, the surface may be decreased 20%.

As stated, the surface given in the charts is for a temperature of zero outside, but it may be made to answer for other outside temperatures by the use of Table 1, as follows: Assuming that it is required to heat a house containing 600 sq. ft. of glass to between 35° and 40° when the outside temperature is 10° below zero, we see by Table 1 that this would be equal to heating the same house to between 40° and 45° at zero.

TABLE 1.—RATIO FOR OUTSIDE TEMPERATURES, OTHER THAN ZERO.

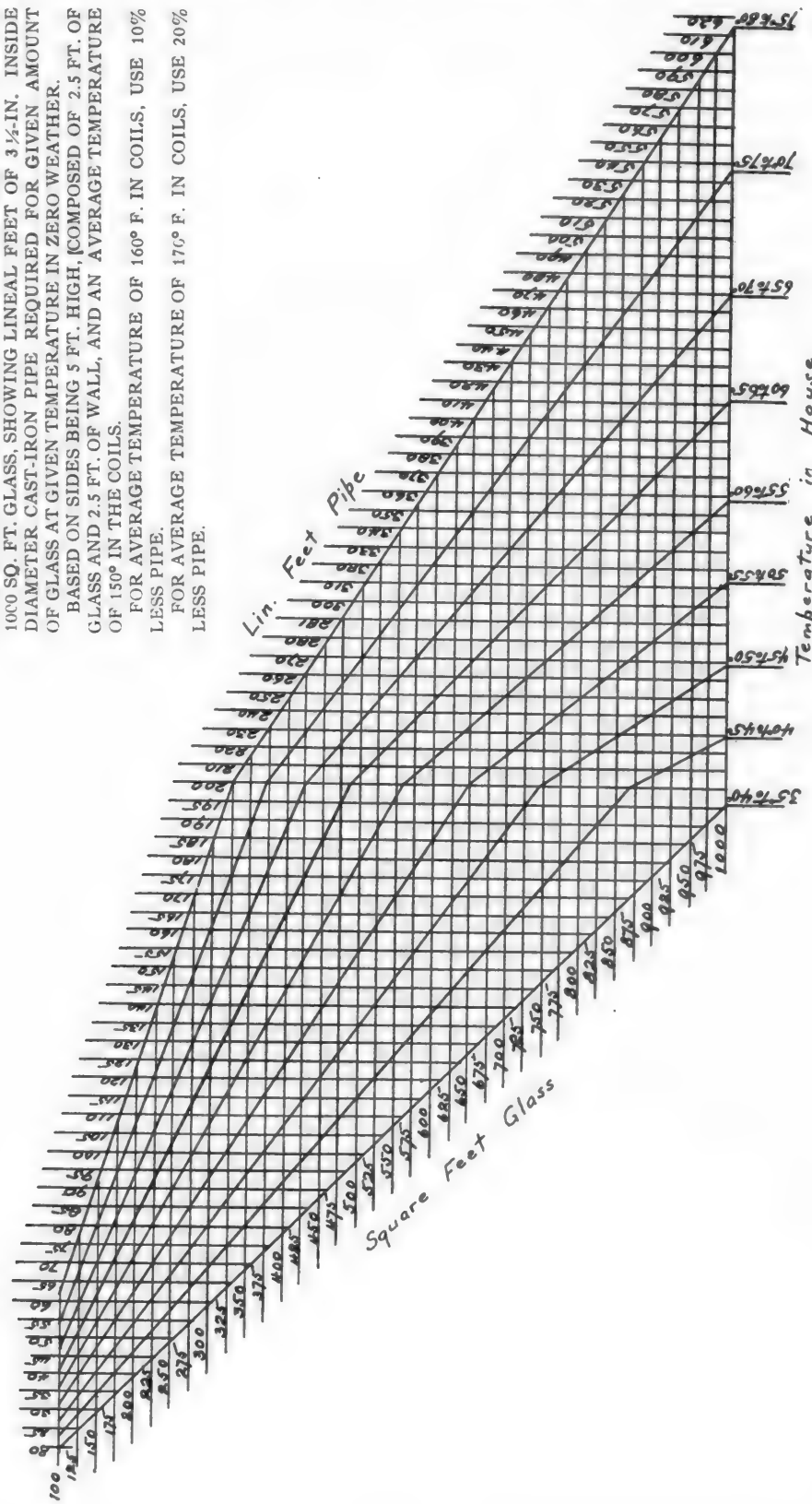
35	to	40	at	+ 10	=	30	to	35	at	0
35	"	40	"	— 10	=	40	"	45	"	0
35	"	40	"	— 20	=	45	"	50	"	0
40	"	45	"	+ 10	=	35	"	40	"	0
40	"	45	"	— 10	=	45	"	50	"	0
40	"	45	"	— 20	=	50	"	55	"	0
45	"	50	"	+ 10	=	40	"	45	"	0
45	"	50	"	— 10	=	50	"	55	"	0
45	"	50	"	— 20	=	55	"	60	"	0
50	"	55	"	+ 10	=	45	"	50	"	0
50	"	55	"	— 10	=	55	"	60	"	0
50	"	55	"	— 20	=	60	"	65	"	0
55	"	60	"	+ 10	=	50	"	55	"	0
55	"	60	"	— 10	=	60	"	65	"	0
55	"	60	"	— 20	=	65	"	70	"	0
60	"	65	"	+ 10	=	55	"	60	"	0
60	"	65	"	— 10	=	65	"	70	"	0
60	"	65	"	— 20	=	70	"	75	"	0
65	"	70	"	+ 10	=	60	"	65	"	0
65	"	70	"	— 10	=	70	"	75	"	0
65	"	70	"	— 20	=	75	"	80	"	0

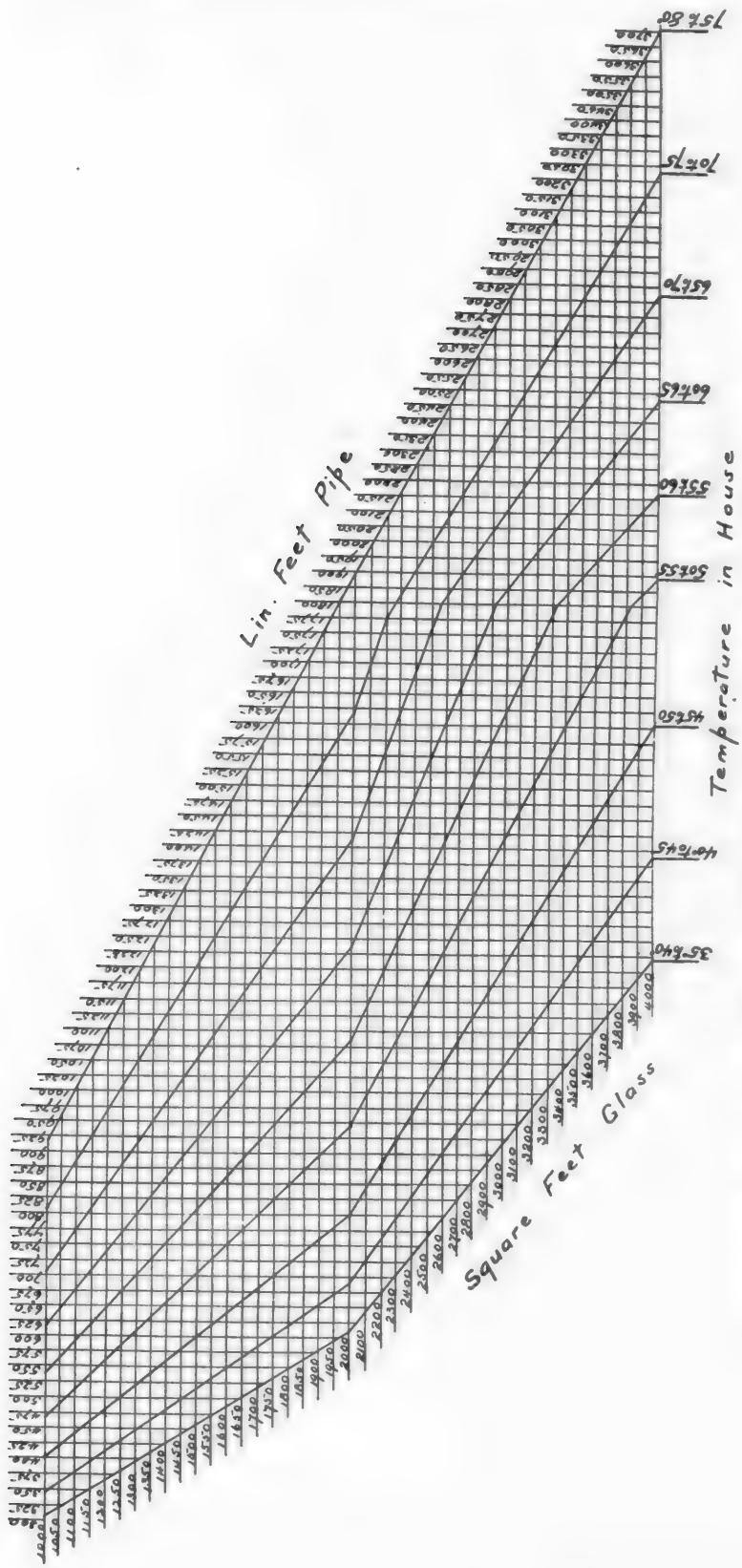
GREENHOUSE HOT WATER HEATING CHART No. 1, 100 TO 1000 SQ. FT. GLASS, SHOWING LINEAL FEET OF 3½-IN. INSIDE DIAMETER CAST-IRON PIPE REQUIRED FOR GIVEN AMOUNT OF GLASS AT GIVEN TEMPERATURE IN ZERO WEATHER.

BASED ON SIDES BEING 5 FT. HIGH, COMPOSED OF 2.5 FT. OF GLASS AND 2.5 FT. OF WALL, AND AN AVERAGE TEMPERATURE OF 150° IN THE COILS.

FOR AVERAGE TEMPERATURE OF 160° F. IN COILS, USE 10% LESS PIPE.

FOR AVERAGE TEMPERATURE OF 170° F. IN COILS, USE 20% LESS PIPE.



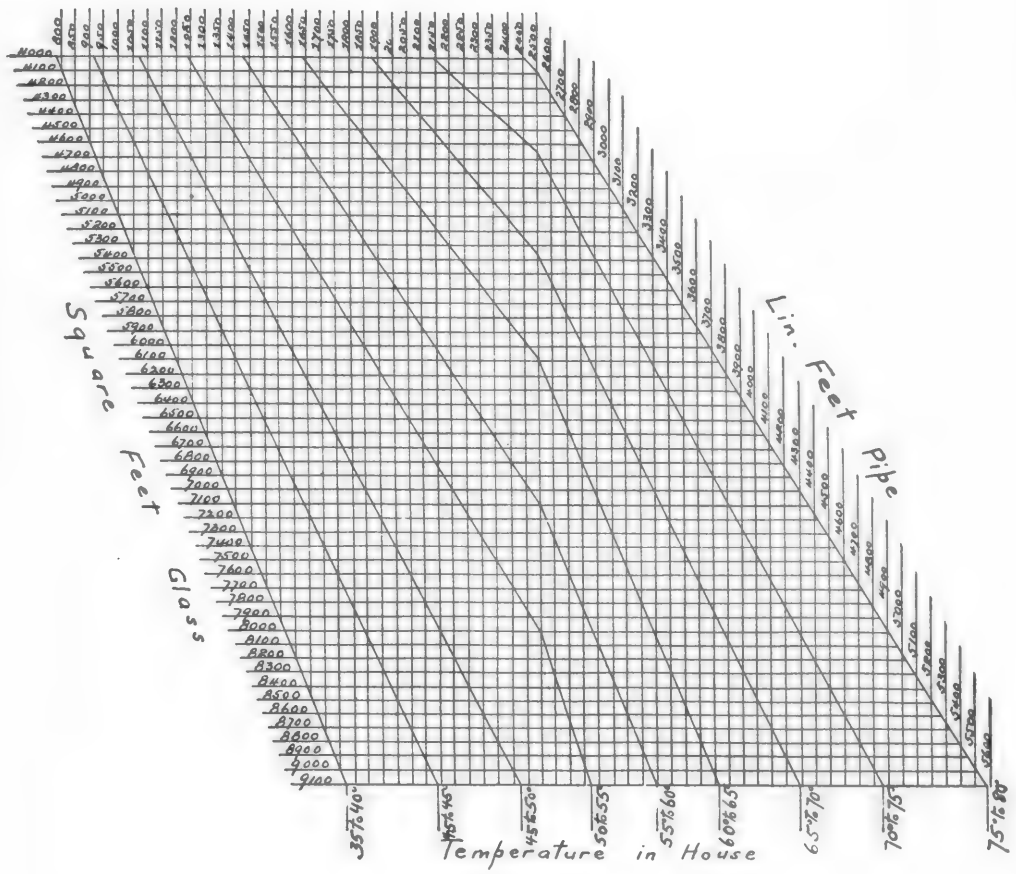


GREENHOUSE HOT WATER HEATING CHART No. 2, 1000 TO 4000 SQ. FT. GLASS, SHOWING LINEAL FEET OF 3 ½-IN. INSIDE DIAMETER CAST-IRON PIPE REQUIRED CONDITIONS SAME AS FOR CHART No. 1

On referring to Chart 1 we find that the line for a temperature of between 40° and 45° in the house intersects the 600 sq. ft. glass line at the point between the line indicating 135 and the line indicating 140 lin. ft. of 3½-in. pipe; therefore, 130 ft. of 3½-in. pipe, with the water at an average temperature of 150°, will be sufficient to maintain 35° to 40° in a house of this size when the outside temperature is 10° below zero.

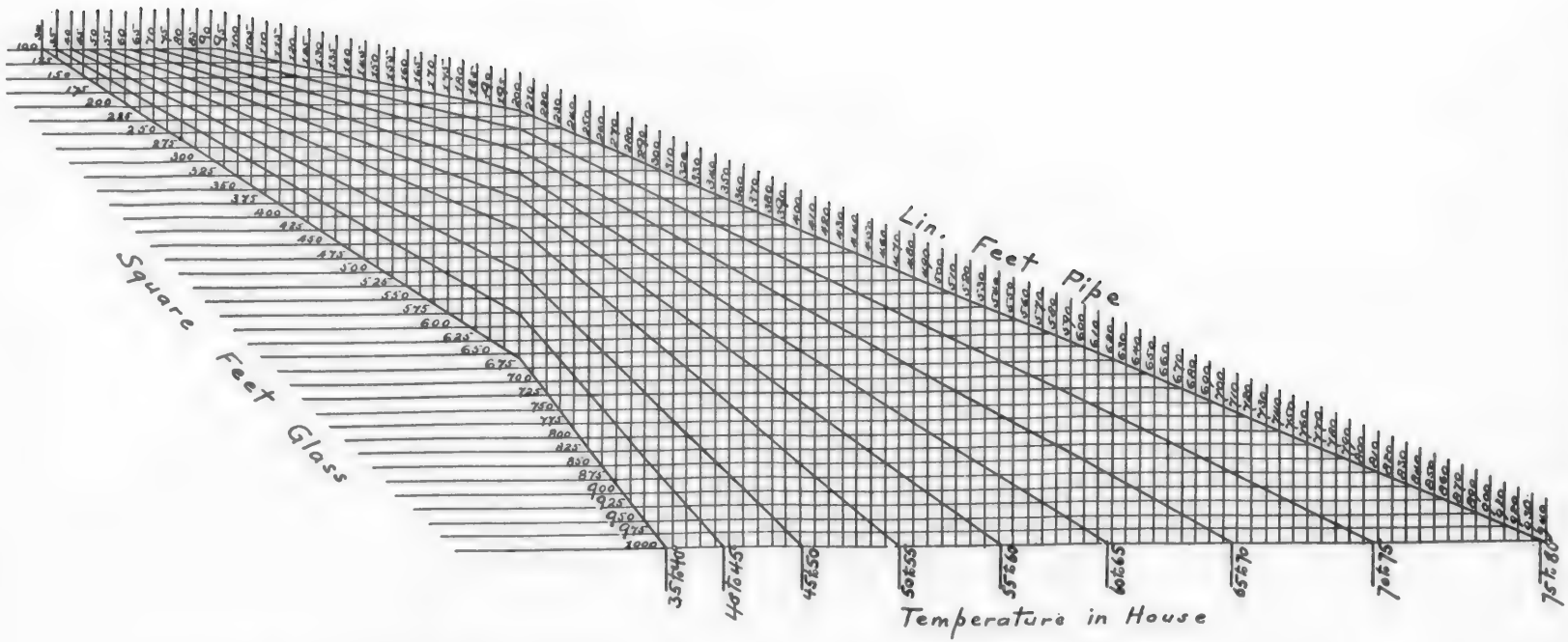
Of course, it is impossible to anticipate in a chart all imaginable conditions and it is necessary to exercise some judgment in the use of these charts and to make allowance for extra cold weather, specially exposed locations or other extraordinary conditions.

I believe, however, that the charts, as I have given them, embodying as they do the experience of years, will be found of value to engineers in estimating greenhouse heating jobs.



GREENHOUSE HOT WATER HEATING CHART No. 3, FOR 4000 TO 9100 SQ. FT. GLASS, SHOWING LINEAL FEET OF 3½-IN. INSIDE DIAMETER CAST-IRON PIPE REQUIRED

CONDITIONS SAME AS FOR CHART No. 1



GREENHOUSE HOT WATER HEATING CHART No. 4, 100 TO 1000 SQ. FT. GLASS, SHOWING LINEAL FEET OF 2-IN. INSIDE DIAMETER WROUGHT IRON PIPE REQUIRED FOR GIVEN AMOUNT OF GLASS AT GIVEN TEMPERATURE IN ZERO WEATHER

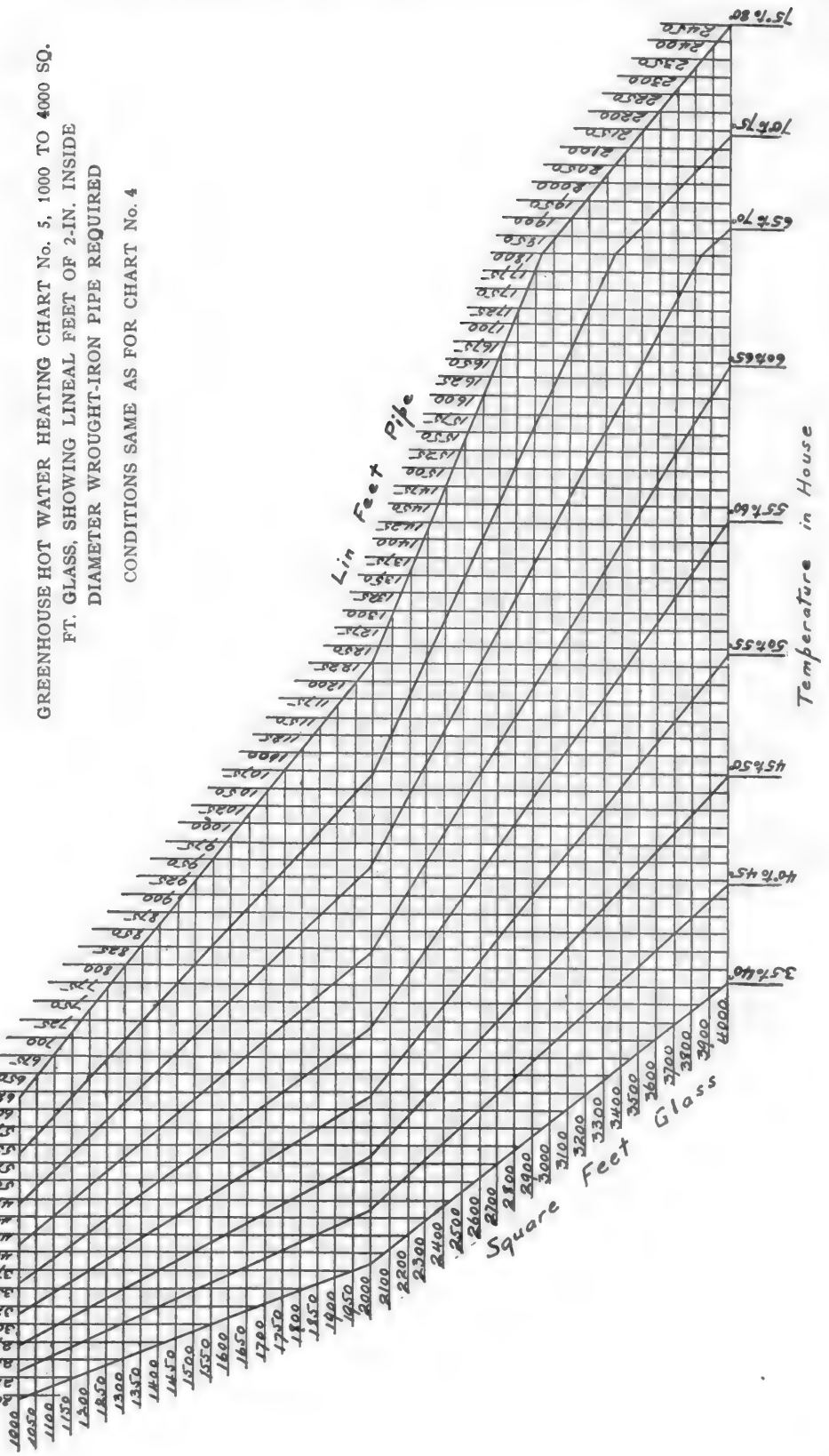
BASED ON SIDES BEING 5 FT. HIGH, COMPOSED OF 2.5 FT. OF GLASS AND 2.5 FT. OF WALL AND AN AVERAGE TEMPERATURE OF 150° F. IN THE COILS

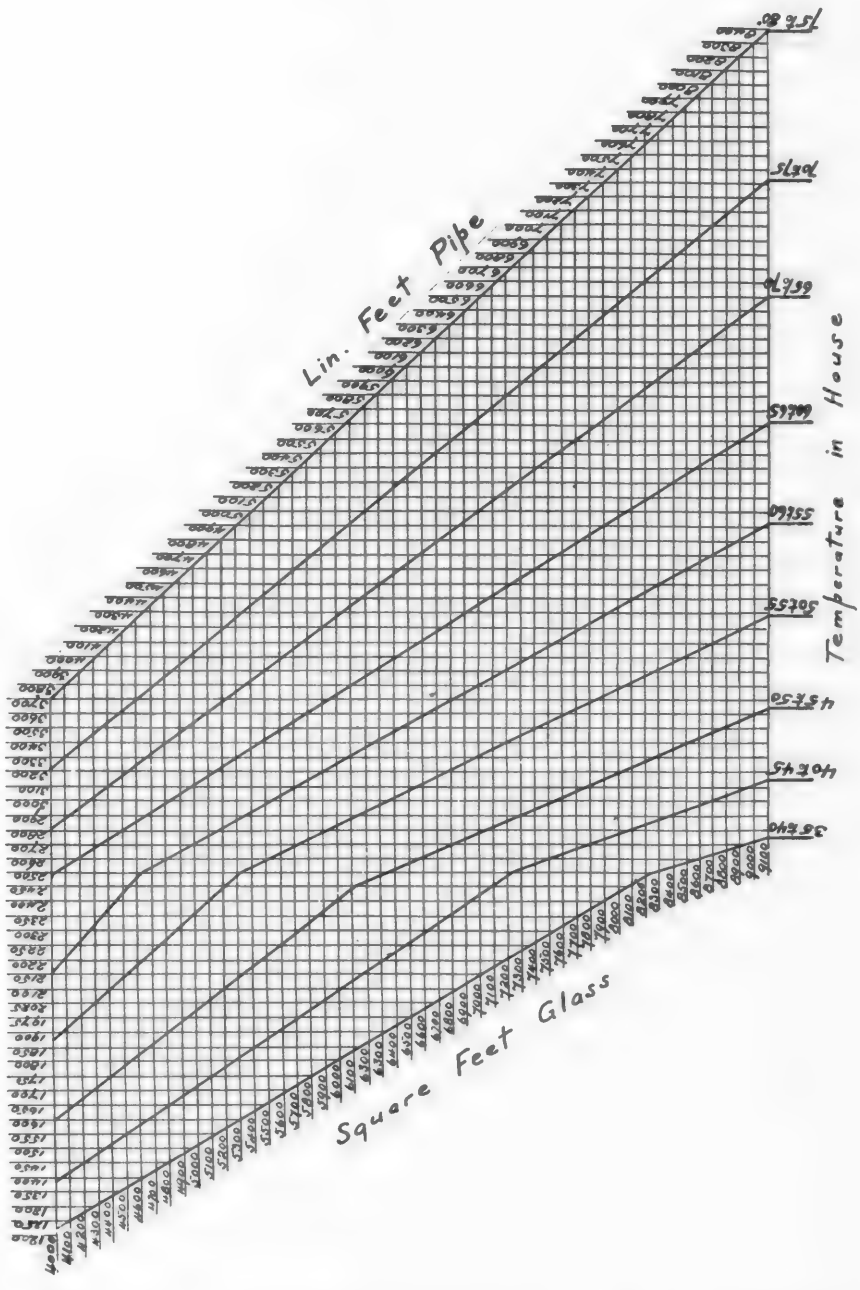
FOR AVERAGE TEMPERATURE OF 160° F. IN COILS, USE 10% LESS PIPE

FOR AVERAGE TEMPERATURE OF 170° F. IN COILS, USE 20% LESS PIPE

GREENHOUSE HOT WATER HEATING CHART No. 5, 1000 TO 4000 SQ. FT. GLASS, SHOWING LINEAL FEET OF 2-IN. INSIDE DIAMETER WROUGHT-IRON PIPE REQUIRED

CONDITIONS SAME AS FOR CHART No. 4



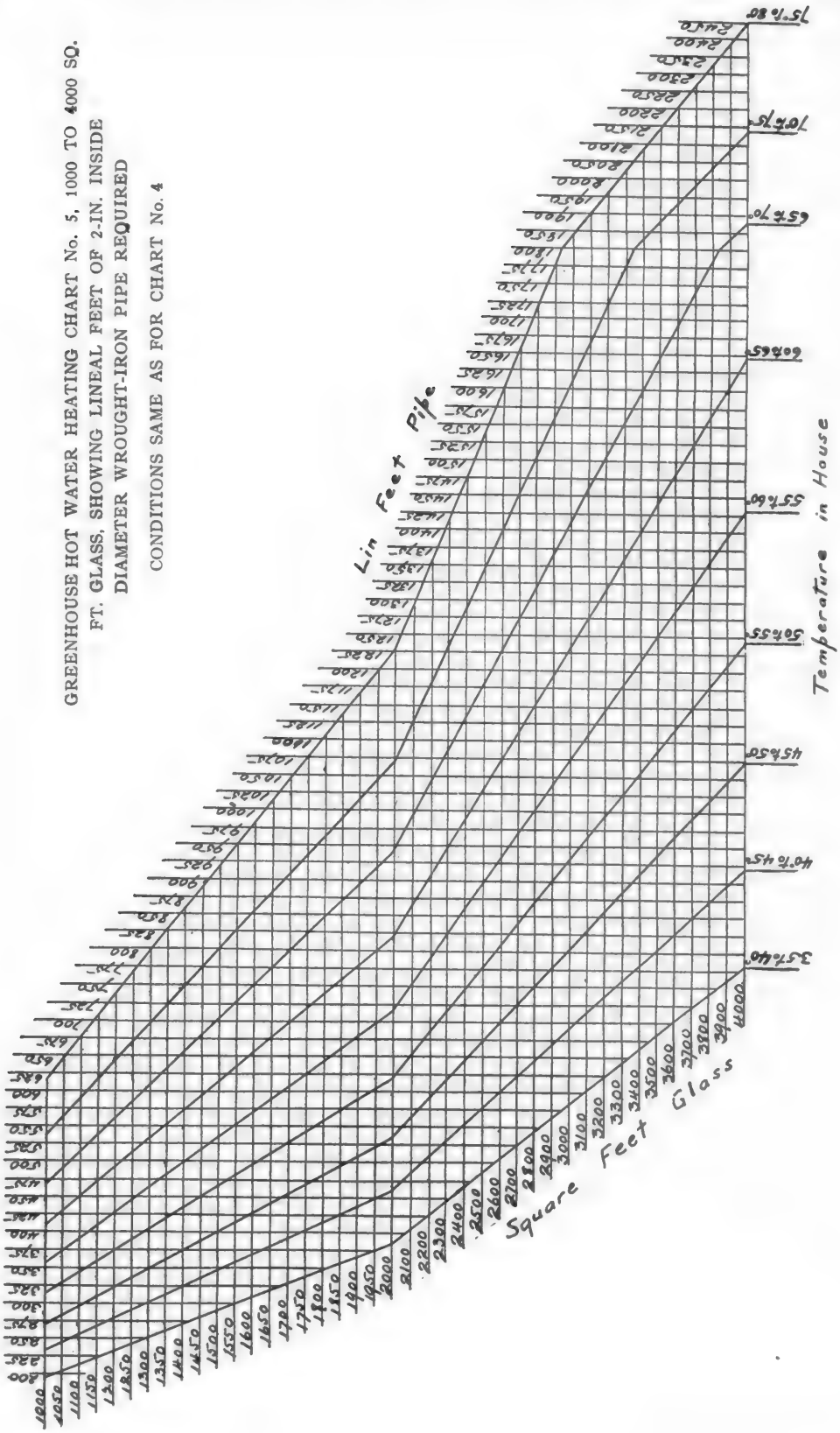


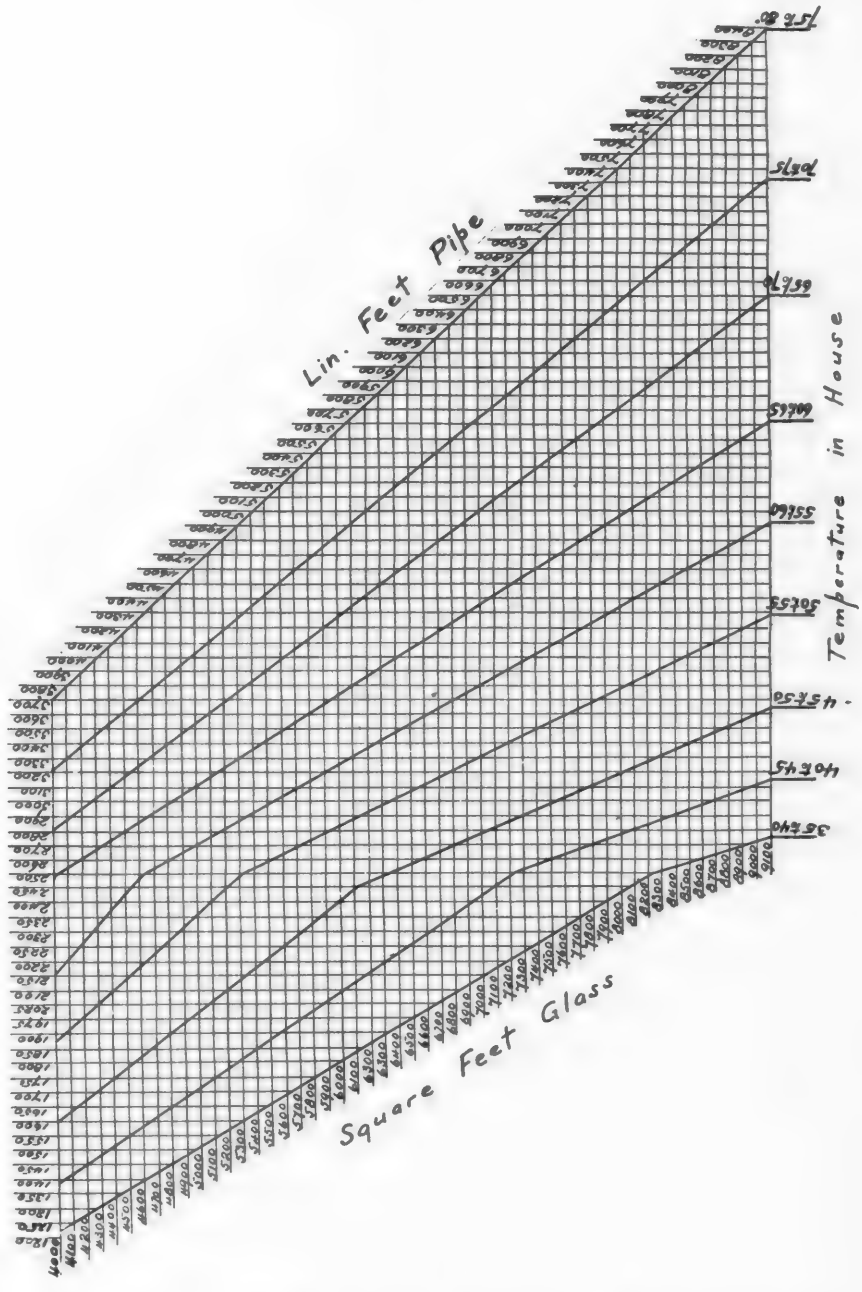
GREENHOUSE HOT WATER HEATING CHART No. 6, 4000 TO 9100 SQ. FT. GLASS, SHOWING LINEAL FT. OF 2-IN. INSIDE DIAMETER WROUGHT-IRON PIPE REQUIRED

CONDITIONS SAME AS FOR CHART No. 4

GREENHOUSE HOT WATER HEATING CHART No. 5, 1000 TO 4000 SQ. FT. GLASS, SHOWING LINEAL FEET OF 2-IN. INSIDE DIAMETER WROUGHT-IRON PIPE REQUIRED

CONDITIONS SAME AS FOR CHART No. 4





GREENHOUSE HOT WATER HEATING CHART No. 6, 4000 TO 9100 SQ. FT. GLASS, SHOWING LINEAL FT. OF 2-IN. INSIDE DIAMETER WROUGHT-IRON PIPE REQUIRED

CONDITIONS SAME AS FOR CHART No. 4

Modern Design in Hospital Heating

Some frank opinions on the prevailing methods of heating and ventilating hospitals, as well as some new "wrinkles" now being tried out in this class of work, were discussed by Clarence W. Williams, speaking before the American Hospital Association at its annual meeting in New York. Only such systems as are applicable to the larger institutions were considered by Mr. Williams.

Considering first the compact or single block hospital, the system generally installed is that using low-pressure steam throughout the building, exhaust steam being furnished, with a back pressure on the engines and the deficiency in the exhaust steam supplemented by live steam through a reducing valve.

"We have learned by experience," said Mr. Williams, "that for this type of building such a system, if well designed, with means of ample size, so proportioned as to provide a perfect circulation with 1 lb. pressure, and to heat the entire building in the very coldest weather with not more than 5 lbs. pressure, gives good results with a smaller initial cost than any other type of heating system. There is the same fault with this as with every other steam system—namely, that of heat regulation—which is practically impossible except by the addition of a temperature control. This, as it relates to fuel economy, will be considered later.

"Where there is more than one main hospital building, and the buildings are widely separated, the low-pressure steam system is not so well adapted to these conditions if true economy and first cost be considered; for if it is desired to keep the back pressure on the engines within reasonable limits, the heating mains must be very large. On the other hand, if the mains are not properly proportioned for load friction and condensation losses, or if made too small, then the back pressure on the engine is increased, with a consequent reduction in power and increase in steam consumption.

"There are many types of vacuum systems—so many that it is hard even for heating engineers to keep informed—and of these there are but two types which are in general use. One type does nothing but remove the air from the radiators through a system of air pipes, they in turn being connected to a vacuum pump or an injector. Its advantages consist of the removal of air from the radiators, thus increasing their efficiency, the reduction in size of the piping and the reduction of the back pressure on the engines because of the vacuum in the air line system. In a well-designed low-pressure steam plant the addition of such a system is really unnecessary, according to the writer's opinion, especially if the automatic air valves are connected to air lines which are connected together and discharge into a convenient receptacle in the basement, thus doing away with unpleasant odors and discharge of steam and water from leaky air valves. In justice to this system, however, there is no doubt that it works well, gives satisfaction, and could be installed in many heating plants with profit to the institution and comfort to the occupants.

"The other type is that in which vacuum valves are placed on the return or condensation ends of the radiators or coils, the bottom of risers, and wherever it is necessary to drain the supply mains; and these valves are connected to the return mains, which in turn are connected to the vacuum pump. This pump handles all the water of condensation in the system and places a vacuum on the whole, thereby making it especially adapted to large installations where otherwise there would be unduly large mains. This system is of value in the remodelling of old steam heating plants, where, through improper design or growth by piecemeal, the piping is too small, thus necessitating the use of live steam at a high pressure to force a circulation.

Under such conditions it can make a good showing in economy and justifies its use. Large claims for economy are made for this type of system because of the vacuum, but while undoubtedly, in theory, it ought to be more economical than low-pressure steam, in practice leaky vacuum valves often nullify all the advantages claimed for it. This type of system is found to be of great value in large installations where steam is necessary for other uses and where, therefore, the one set of mains can serve all purposes. The last feature has often been the deciding point in favor of wholly steam systems over other types, and has been made much of—entirely too much, in the writer's opinion.

Another system which is in general use in many large hospitals is the hot blast or so-called Plenum system. This consists of a series of fans or blowers forcing heated air through ducts of brick or galvanized iron into the wards and other parts of the buildings, the air being heated by coils placed alongside the blower, or by radiation at the base of the heat flues. This system has many advantages and has been more generally adopted for large institutional work than perhaps any other, though the cost of maintenance is, no doubt, the greatest. The advantages of this system are the concentration of the heating apparatus at one point, the elimination of all steam piping throughout the buildings, and the ventilation or air changes given. The disadvantages are the cost of operation, the power required to drive the fans, and that, if the air is recirculated (as is sometimes done to save expense), it then has no advantages over any direct system, but an additional drawback of the extra cost of operating the fan day and night in very cold weather.

"In nearly all hospital buildings where ventilation is actually required, the method now adopted by the most progressive engineers is to have the ventilation system entirely free from heating—that is, in the rooms and wards is placed sufficient direct radiation to take care of the heat losses through windows and exposed walls and a certain amount of air leakage, the air for ventilation being delivered into the rooms as tempered air at about 70° F. and in such quantity as is required by the number of occupants and the purpose for which the room is used. By this method the temperature of the room can be regulated to any degree desired, and on pleasant days, when windows or doors may be opened, the fan introducing tempered air for ventilation can be stopped and cost of operation saved, while sufficient heat will be maintained by the direct radiation to keep the building comfortable.

STEAM HEATING PIPES UNDER FLOOR

"Another type of heating which has recently been introduced by a large manufacturing concern in New York State is that which inserts lines of steam pipes in the construction under the floors and thus warms the rooms by heating the floors only. This is quite a daring departure from any of the so-called "tested and tried" systems, and the writer does not agree that it could be successfully used in modern hospital practice. It may apply to such buildings as factories, where the occupants are on the floors for only a few hours a day, but I do not think a nurse or attendant could work on such floor the hours required of them in most of our hospitals. The high temperature to which the floors must be heated in order to maintain an even temperature in exposed rooms does not warrant the recommendation of this system for hospital practice, and it will not, therefore, further be discussed.

(To be concluded)

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RECENT tests of vacuum cleaning machinery have served to emphasize again the lack of a standard method for testing such apparatus. The fact that one of these tests was conducted without reference to the amount of horsepower consumed by the vacuum pump, for instance, is a point that is being made much of by those who feel that this is the vital point to be covered. They call attention to the fact that inexperienced architects and engineers throughout the country seem to be at a great variance as to the question of the amount of air they wish to handle per sweeper and the vacuum they will use in cleaning. Among the inexperienced it is customary to call for a one-, two- or three-sweeper plant and let it go at that. Yet this means practically nothing in the way of volume of air and amount of vacuum required for the system, as each manufacturer of vacuum cleaning machinery will figure on a different volume of air per sweeper and a different vacuum to operate on than his competitor. The result is that possibly two systems are offered, each known as a two-sweeper plant, and, as a matter of fact, the actual air displaced by one of the systems will possibly displace 20 cu. ft. of free air per minute while maintaining a vacuum of 5 in., and the other may displace 100 cu. ft. of free air per minute while maintaining 10 in. of vaccum. Thus, although both plants are termed two-sweeper plants, one of them is over five times as large as the other.

A SUGGESTION in this connection, which seems reasonable, is that every architect or owner, in requesting a proposal for furnishing a vacuum cleaning system, should state in the specifications the number of cubic feet of free air to be exhausted per minute for each sweeper while maintaining such vacuum as he deems proper and advisable for the cleaning to be done. When such specifications are made, every bidder submitting a proposal would base his price on performing and meeting certain specified conditions and would guarantee the actual horsepower required to perform such work.

AN ADVANCE in our date of publication, made necessary to comply with the plans of the Postmaster-General to ship monthly periodicals by fast freight instead of by mail, has made it impracticable to publish the monthly weather charts, which we issue during the heating season, in the issue for the succeeding month to that covered by the charts. The October, 1911, weather records, therefore, will appear in the December issue, and so on during the winter.

The Operation of Back Pressure and Atmospheric Relief Valves

Back pressure or atmospheric relief valves, such as are used to protect exhaust steam heating systems, feed water heaters, absorption ice machines, cooking kettles, and other apparatus using exhaust steam against dangerous accumulation of pressure, belong to the general class of safety valves, differing therefrom principally in that they are designed to discharge steam at low pressures. This difference, however, has important consequences as regards the design and proportioning of the valves, since steam escaping from a safety valve at a pressure of 150 lbs. has a velocity of from 2000 to 3000 ft. per second, and as the density under these conditions in the smallest cross-section of the orifice corresponds to a pressure about 60% as great as the initial pressure, a small opening is able to discharge a considerable weight of steam.

On the other hand, steam under a back pressure of 6 lbs. escaping to atmosphere has a velocity of only 1000 ft. per second or so, so that in order to discharge the same weight of steam in a given time the area of the valve opening must be about 30 times as great as in the case of the safety valve. These facts demonstrate at once the futility of the occasional practice of putting ordinary safety valves on feed water heaters and similar apparatus. Due to its small discharge area, a safety valve has hardly any perceptible influence on the rise in back pressure if the exhaust to atmosphere be blocked while the engine is running at full load.

Safety exhaust outlet valves for exhaust steam service are commonly known under two different names—namely, back pressure valves, where the pressure of the steam is normally higher than that of the atmosphere, and atmospheric relief valves, where the pressure underneath the valves is normally much less than atmosphere, as in condenser service, the valve being provided to prevent dangerous rises in pressure, as in case of failure of the circulating water. Back pressure valves proper are usually fitted with means for adjusting the pressure at which they will discharge or "pop," while atmospheric relief valves are usually so arranged that a water seal can be maintained over the valve in order to prevent the infiltration of air between the valve and seat. Many valves, with slight modifications, can be, and are, used indifferently for either service.

The various types of valves on the market can be brought under two general classifications, those having a single plain valve disk, and, second, those having balanced disks. Taking the simple disk as an example, let us study the requirements and mode of action. The back-pressure valve is intended to limit the pressure within the exhaust steam system by opening and allowing the escape of steam as soon as the pressure begins to rise above a predetermined amount. Where the volume of exhaust steam received by the system is only a little greater than that consumed therein, it frequently happens that the valve must open and close at each pulsation of the engine—that is, twice per revolution in the case of a single-cylinder engine. The disk may, therefore, be called upon to rise and fall from 100 to 300 times per minute. In many cases, the disk is held to its seat by weights, so that not only must the valve disk itself lift with this frequency, but the weight as well.

The distance through which the valve disk must move during each oscillation is determined by the amount of exhaust steam to be discharged, since the maximum velocity at which the steam can escape is rigidly determined by the back pressure. If, by opening to its widest extent, the valve is unable to discharge the amount of steam on hand, the pressure within the system will continue to rise until the velocity through the valve is sufficiently accelerated, or until some part gives way, or until the engine is stalled. A little elementary geometry will show that in order to present a free area of opening equal to the area of the circle formed by the valve seat, a valve disk will need to lift through a distance equal to the quarter of the diameter of the valve seat—that is, an 8-in. valve will need to lift 2 in., a 16-in. valve 4 in., a 24-in. valve 6 in., and so on.

As a matter of fact, back-pressure valves, as actually constructed, rarely or never lift as far as this. This may be explained in the following manner: Suppose the valve is set for 10 lbs. back pressure, and has an area of 100 sq. in. Then it will be necessary to put upon the valve a load of 1000 lbs., either by means of a weight, by means of springs or otherwise. As soon as the pressure beneath the valve rises to 10 lbs. per square inch, the valve will lift, and the steam will begin to escape under the edge of the disk. This, however, will be accompanied by a reduction in the pressure of the steam, since it is only by loss of pressure that the steam can gain velocity, so if we conceive a valve to be lifted sufficiently to permit of the escape of a jet of steam at the full velocity due to the pressure, filling the entire circle of the valve disk, we must conceive that the static pressure of the steam beneath the valve is zero.

Under these circumstances, the question naturally arises as to what will sup-

port the 1000 lbs. with which the valve is loaded. The only force available is the impulse of the jet of steam escaping from the valve. If this jet of steam were turned entirely through a right-angle, without losses of any kind, it should be able to support a weight as great as the original load on the valve. In practice, however, the jet of steam is rarely turned through a complete right-angle, and, moreover, the coefficient of discharge of the nozzle formed by the opening in the valve seat is much below unity, so that the valve at best opens only grudgingly, and does not discharge the full quantity of steam that it might be expected to discharge on the basis of the area of the valve opening and the difference in pressure producing the velocity. The result is that all valves of the single-disk type show a marked increase in back pressure if the load rises to anywhere near the supposed capacity of the valves. Also, since the valve never rises to the theoretical limit of one-quarter of its diameter, the area of discharge under the valve is determined by the length of the periphery, rather than by the area of the opening in the valve seat.

The lift of the valve has an important bearing upon another phase of the operation of valves of this kind, and that is, the hammering action upon the seat. The greater the diameter of the valve, the greater the distance through which it must lift to give an area of opening comparable to the opening in the valve seat, but also the greater the lift, the greater will be the velocity and the hammering action when the valve comes back upon the seat again. This must necessarily be the case, since the load upon the valve—that is, the weight of the valve plus the weight or the force of the spring with which it is loaded—is determined by the area of the opening in the valve seat. Moreover, since the area of this opening increases as the square of the diameter, while the periphery increases only directly as the diameter, the intensity of the blow upon the edge of the valve, and upon the valve seat, increases rapidly with the diameter; in fact, we may say that the energy of the blow, since the lift should increase directly with the diameter, and since the load per unit of length on the periphery should increase directly with the diameter, will increase as the square of the diameter, and as the destruction or damage to the valve seat is proportional to the energy expended in the blow. it is obvious that the proper design of back-pressure valves is a very difficult matter.

The more or less theoretical deductions above cited are aptly borne out by practical experience. The disastrous effects of the hammering of the valve seat, especially where it is essential to maintain a nice fit between the valve and its seat, as in high-vacuum work in connection with steam turbines, will be apparent. It is the usual practice to start engines or steam turbines non-condensing—that is, exhausting to atmosphere—and after the engine or turbine is properly warmed and drained and is operating satisfactorily, it is thrown over to the condenser. During the non-condensing period, the atmospheric relief valve is held open by a hand adjustment, leaving a clear passage for the steam to the atmosphere. At the moment of throwing over, however, this adjustment is released, and the valve is temporarily allowed to hammer on its seat, while the main exhaust gate valve between the engine and the condenser is being opened. As soon as the vacuum reaches the atmospheric relief valve it will hold it to its seat, and the operation is completed. The oscillations of the relief valve are more or less efficiently steadied by means of a dash-pot, but with the rubber composition face and brass disk usually employed in atmospheric relief valves, the rubber, being exposed to steam at 212° F., and, in the case of engines, to oil in the exhaust steam, soon fails, and in all condensing plants the most common causes of low vacuum are leaks through the relief valve.

The sluggish action of the large single-disk valve is due to the inertia of the heavy disk and the connected weight, and when the main gate valve to the condenser is opened a great drop in vacuum almost invariably occurs, due to a certain volume of air being drawn into the condenser through the relief valve before the disk of the latter can seat. In the case of a jet condenser, this is extremely objectionable, particularly where the condenser must operate with a high injection lift, and in many cases the throwing over is a difficult and hazardous procedure, since the drop in vacuum at the moment of opening the exhaust gate valve is often sufficient to cause the injection water to be lost, and considerable experience and judgment on the part of the operating engineer are required to adjust the atmospheric relief, the main exhaust gate valve and the injection valve, so that the throwing over may be accomplished with the minimum damage to the relief valve and without losing the injection water. Loss of injection water, it should be remembered, entails starting all over again, priming the condenser, etc., and considerable delay, as the rush of steam into the condenser will have warmed up the latter so that pumping out the condenser by means of the air pump will be a much longer and more tedious operation than before.

In order to diminish the diameter of the valve opening and, therefore, the lift, some makes of valves are fitted with balanced or double-seated disks. This expedient is effective to a certain extent in accomplishing its purpose, since the

mass to be accelerated and brought to rest with each stroke of the valve, and the distance of travel, are both diminished. Certain other difficulties, however, arise. A double-seated valve that will be tight under all conditions of temperature and pressure is difficult and expensive, if not impossible, to make, and since the only force tending to open the valve is the unbalanced steam pressure on the area which one disk possesses in excess of the other, there is more probability of the valve sticking.

Some further mention should be made of the means adopted for holding valves in the closed position. Where weights are used, the amount of back pressure is commonly regulated by shifting the position of the weights on the lever arm, but it frequently happens that more weights are hung upon the arm than was originally intended, or that the arm comes in contact with some obstruction, or is tied down to prevent its free lifting, any of which causes may result in a disastrous explosion; in fact, the use of weighted safety valves in steam boiler practice has been largely discontinued for very similar reasons.

Convenient Means for Determining Flue Gas Temperatures

In the operation of a steam boiler, one of the most important quantities is the temperature of the gases passing to the chimney, since, other things being equivalent, this temperature is a direct measure of the portion of the heat of the fuel which is wasted or not utilized. If we assume 1 lb. of coal having a heating value of 14,000 B. T. U. to be burned with 20 lbs. of air, which is about the smallest ratio of air to coal found in actual commercial practice, the temperature in the furnace after complete combustion should be about 2500° F. above the temperature of the atmosphere. The temperature of steam at 150 lbs. gauge pressure is 366° F., and if it were possible to transfer all of the heat in the gases above this temperature (and it is impossible to transfer any below this temperature) to the steam and water in the boiler, the efficiency of the boiler would be 88%—that is, the boiler would recover all but 12% of the heat of the coal.

As a matter of fact, no boiler reduces the temperature of the gases to the temperature of the steam. There is, therefore, a limit to the amount of boiler surface that it pays to put in. Commercial practice some years ago established this limit of surface at about 10 sq. ft. of boiler surface per boiler horse power, but recent practice has shown that a 1 B. H. P. can be produced from much less surface, as 3 to 5 sq. ft., or even less, and in some plants it has become a matter of routine to drive the boilers at about 60% above the nominal rating of 10 sq. ft. per boiler horse power.

Even disregarding the number of square feet of boiler heating surface employed to produce a boiler horse power, it is found in commercial plants that the chimney gases escape at temperatures considerably above the steam temperature, as at 450° to 500° at least, which

GREEN'S TEMPERATURE PENDANTS FOR DETERMINING STACK TEMPERATURES (EXACT SIZE)

represents a waste of from 20% to 40% of the heat of the coal, depending partly upon the amount of air used to burn a pound of coal.

The usual and most practicable way of recovering waste heat from chimney flue gases is by means of the economizer, the heating surface of which, because of the lower temperature of the contents, is much more active in absorbing heat than an equal amount of surface in the last pass of the boiler. That is, since the economizer receives water at a temperature of 80° to 150° and discharges the water at 200° to 300°, with an average temperature for the whole economizer of around 200° to 220° F., say, it is able to absorb about twice as much heat from 500° F. gases as can the boiler surface.

Indicating and recording thermometers and pyrometers are sometimes put in for measuring the temperature of flue gases, but their use is not general, due partly to their cost and also to the fact that many types of instruments are not reliable or break down in service. There is, therefore, a demand for cheap and

efficient means of determining flue gas temperatures which the Green Fuel Economizer Company, of Matteawan, N. Y., has met by devising the temperature pendants shown herewith. These pendants consist of fusible alloys of the proper composition to indicate the desired temperatures.

It is an interesting fact that the melting points of such metals were found to be too uncertain and evasive to be used as temperature tests. That is, it is difficult to tell the exact point at which the metal melts, since it does not change suddenly from a hard solid to a liquid, as does water, but goes through an intermediate softening stage similar to iron and many other substances. Even after the metal is completely melted, a hard skin of oxide is usually found to have been formed upon its surface, which prevents the metal running easily and, therefore, is apt to confuse the determination of the exact temperature.

The expedient was, therefore, devised of using the tensile strength of the metal, instead of the melting point, as the true indication of temperature. In other words, the pendants are made with a large body, having a certain definite weight, suspended from a narrow neck, and the composition of the metal and cross-section of this neck are adjusted until the body of the pendant will pull the neck in two and fall at some desired temperature.

In actual use the pendants are hung upon a small hook made upon the end of a long wire, which is introduced into the flue so that the pendants will be at the desired point. The best way is to begin with the lowest temperature pendant and proceed until the one is found which will not fall off after 5 or 10 minutes' exposure. The temperature will then lie somewhere between the temperature marked on the last pendant and the next to the last pendant used. In doing this, it is quite essential that several different points in the flue be tried, as it very frequently happens that one part of the flue is occupied by gases much hotter than the gases in other parts of the flue.

TABLE 1.—PERCENTAGE OF HEAT ESCAPING IN CHIMNEY GASES AT VARIOUS FLUE TEMPERATURES, ASSUMING 26 LBS. OF AIR PER POUND OF COAL, AND 14,500 B. T. U. PER POUND OF COAL.

Chimney Temperature Degrees Fah.	B. T. U. in Gases Per Pound of Coal	Percentage of Total Heat in Gases	Ratio of Heat in Flue Gases above 60 deg. to heat absorbed by boiler, assuming 15% Loss through Grates and Radiation, per cent.
200	905	6.25	8.
300	1555	10.7	14.4
400	2200	15.2	21.8
500	2850	19.68	30.2
600	3500	24.1	39.6
700	4150	28.6	50.6
800	4790	33.0	63.4
900	5440	37.5	79.0
1000	6090	42.0	97.5

At present the Green Fuel Economizer Company has perfected pendants for three temperatures—i. e., 425°, 500° and 550° F.—representing, respectively, the temperature at which the use of the economizer is justified with coal at commercial prices, the temperature at which an economizer is a good investment in all cases, and the temperature at which neglect to install an economizer becomes an inexcusable waste.

For use in connection with these pendants the Green Fuel Economizer Company has calculated three tables which

TABLE 2.—MINIMUM ECONOMIC TEMPERATURE OF GASES LEAVING THE BOILER.

Operating 3100 Hours per Year				Operating 8760 Hours per Year			
Price of Coal Per Ton	Cost of Boiler Horse-Power Year	Critical Temperature Difference Degrees F.	Economical Temperature of Gases leaving Boiler. Pressure=150 lbs. gauge Degrees F.	Price of Coal Per Ton	Cost of Boiler Horse-Power Year	Critical Temperature Difference Degrees F.	Minimum Economical Temperature of Gases, Boiler Pressure=150 lbs. guage Degrees F.
$2.00	$14.25	319	685	$2.00	$34.10	133	499
2.50	16.97	268	634	2.50	41.70	109	475
3.00	19.68	231	597	3.00	49.40	92	458
3.50	22.40	202	568	3.50	57.10	80	446
4.00	25.10	181	547	4.00	64.70	70	436
4.50	27.80	163	529	4.50	72.40	63	429
5.00	30.50	149	515	5.00	80.00	57	423

TABLE 3.—MINIMUM ECONOMICAL TEMPERATURE OF FLUE GASES FOR DIFFERENT PRICES OF COAL FOR AN ECONOMIZER PLANT OPERATING 10 HOURS PER DAY AND 310 DAYS PER YEAR.

Price of Coal	Cost of Boiler Horse-Power Year	Critical Temperature Different Degrees F.	Temperature Flue Gases Leaving Economizer for Various Temperatures of Feed Water, degrees F.		
			100°	150°	210°
$2.00	$14.25	112.2	212.2	262.2	322.2
2.50	16.98	94.5	194.5	244.5	304.5
3.00	19.68	81.4	181.4	231.4	291.4
3.50	22.40	71.5	171.5	221.5	281.5
4.00	25.10	63.8	163.8	213.8	273.8
4.50	27.80	57.5	157.5	207.5	267.5
5.00	30.55	52.5	152.5	202.5	262.5
FOR ECONOMIZER OPERATING 24 HOURS PER DAY AND 365 DAYS PER YEAR					
$2.00	$34.10	47.0	147.0	197.0	257.0
2.50	41.75	38.3	138.3	188.3	248.3
3.00	49.40	32.4	132.4	182.4	242.4
3.50	57.10	28.0	128.0	178.0	238.0
4.00	64.70	24.7	124.7	174.7	234.7
4.50	72.40	22.10	122.1	172.1	232.1
5.00	80.00	20.0	120.0	170.0	230.0

NOTE.—The best temperature for the gases leaving the economizer is affected to a certain extent by the conditions in the plant under consideration.

we reproduce herewith. The first shows the percentage of heat escaping in chimney gases at various flue temperatures, assuming 26 lbs. of air per pound of coal, and 14,500 B. T. U. per pound of coal. The second, the minimum temperature to which it pays to cool the gases by means of boiler surface only; and the third, the minimum temperature to which it pays to cool the gases by means of an economizer. These tables are based upon an investment of $15 per nominal boiler horse power in the boiler and $5.00 per nominal boiler horse power in the stoker, grates and draft apparatus, interest at 5%, and sinking fund and maintenance charges at 12%. The figures for the economizer are based on $1.00 per square foot and annual charges for interest depreciation, maintenance power and attendance at 12%, the economizer being notably longer lived and requiring less care and attention than the boiler.

The Green Fuel Economizer Company, we are advised, will be pleased to send samples of these temperature pendants to any one connected with a steam plant who would be interested in determining the temperature of chimney flue gases.

Accident with Gas Stove Due to Ventilating Fan

A singular accident, resulting from the use of an exhaust fan in a room containing a gas stove, is reported from Germany by *Domestic Engineering*. The accident happened in the club room of a restaurant, about 18 ft. square, with a door on one side and two windows on the other. A gas stove about 36 in. wide connected to a flue through 7 ft. of piping, was located on the side near the door, while between the windows an electrically driven 12-in. exhaust fan had been mounted on the wall.

Several of the patrons of the restaurant had retired to the club room after luncheon and, owing to a sudden chilly spell, closed the doors and windows and lighted the gas stove. As the room soon became stuffy with cigar smoke, the ventilating fan was started.

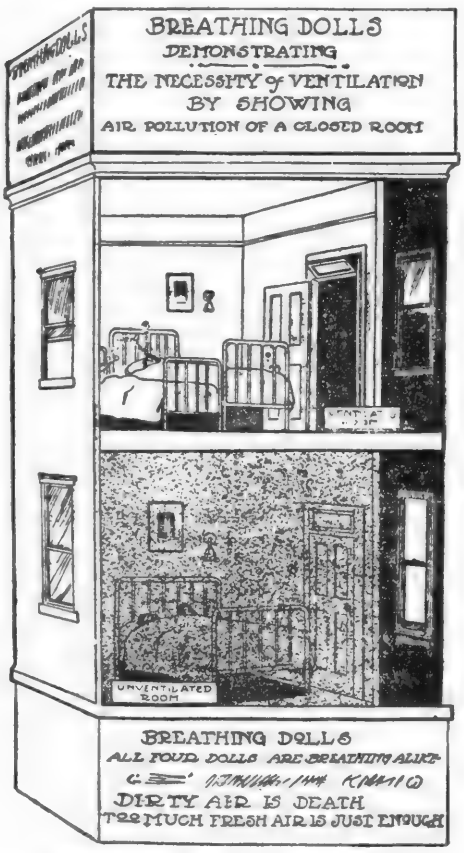
When the door was opened a half hour later by the manager the room was found to be full of escaping gas and the diners asleep. They were hurriedly awakened and the room aired, the guests fortunately suffering no more serious harm than headaches.

An examination brought out the fact that the suction of the fan had drawn the products of combustion from the gas stove out into the room, with the result that the supply of oxygen was reduced until the flames in the gas stove were extinguished. The room then commenced to fill with gas, which might easily have produced serious consequences but for the timely opening of the door.

Breathing Dolls to Demonstrate Good Ventilation

The opinion has often been expressed that if air were colored, with deepening shades for increased degrees of vitiation, an object-lesson would be presented demonstrating to the most confirmed skeptic the valve of pure air. A unique attempt to portray such an object-lesson is being made by Dr. C. St. Clair Drake, of the Chicago Board of Health, using dolls to represent human beings. The "breathing dolls," as they are called, are connected by rubber tubes to a small electric pump, which forces incense through their nostrils. The action of the pump is intermittent to represent breathing.

A demonstration box is used containing two rooms furnished as miniature bedrooms. One side of each of these rooms is of glass, fully exposing the interior to view. Two of the dolls lie abed in each room, one of which has its windows and doors wide open and the other having all openings closed. The pump is then started, supplying equal quantities of incense to the dolls in each room. In the closed room the air soon becomes filled with the incense, so that the dolls can be but dimly seen. In the open room the puffs of incense proceeding from the dolls' nostrils diffuse through the air and pass out, leaving the room almost entirely free of smoke.



DEMONSTRATION CHAMBERS FOR BREATHING DOLLS

The "breathing dolls" in their miniature bedrooms were recently on exhibition at the International Municipal Congress in Chicago, and Dr. Drake has had many calls from child welfare committees and similar organizations in other cities to send on the exhibit for show purposes. Those who have seen the demonstration pronounce it one of the most striking arguments in the cause of good ventilation that has ever been devised.

Current Heating and Ventilating Literature

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the articles mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

CENTRAL STATIONS

Combination Heating and Generating Plant at Springfield, Ill. El. Wld. Sept. 2, 1911. 8 figs. 4300 w. Describes unique features of flexibility of equipment in station of light, heat and power company. 20c.

HOT-WATER HEATING

Economics of Hot Water. Ira N. Evans. Power. Sept. 12, 1911. 5 figs. 7000 w. Gives some actual results in the form of curves and tables from a plant and also a method of getting at the coal consumption and the cost of exhaust heating applicable to any plant. 20c.

STEAM HEATING

Electricity Supply and Exhaust Steam Heating. Francis H. Savies. El. Rev. Sept. 8, 1911. 5 figs. 4000 w. 40c.

Ozonized Air for London Tubes

One of the strongest objections made to traveling underground in London is the fact that the air is impure and often stifling. What promises to be a revolution in this particular is a plan which has recently been announced by the authorities of the Central London Railway Co., according to which a system of ventilation will be installed capable of pumping daily 80,000,000 cu. ft. of ozonized air into the tube stations and tunnels of that company.

One plant is already in operation and it is hoped that similar ones will soon be completed at every station along the line. It is stated by one of the officials that the plant at each station will pump 400,000 cu. ft. of air per hour into the station, or at the rate of 900 cu. ft. per person per hour.

The air is drawn from outside through a filter screen, which removes dust and dirt and impure gases. A part of the air is then highly ozonized by being passed over highly electrified plates, the proportion of ozone in the whole being one part in 10,000,000. The air is driven by fans to the level of the bottom of the station, and two-thirds of it is distributed over the platform by ducts, with outlets at a height of 7 ft. above the platform. The remainder is driven into the tunnel. The size of the pumping plant is such that it can be installed in a chamber 10 ft. by 8 ft. by 4 ft., and there are 2 miles of duct work.—*From Deputy Consul General Carl R. Loop, London.*

Health Officer of Columbus Urges Better Ventilation

That many public meeting places, stores, factories, moving-picture theaters and street cars of Columbus, Ohio, are in need of better ventilation is the belief of Health Officer J. W. Clemmer, who recently submitted his annual report to the mayor and council of that citv.

"The campaign against tuberculosis should be aided by the adoption of regulations requiring ventilation of all places open to the public," says Dr. Clemmer.

One of the chief features of the report is a warning against the use of gas stoves that are not ventilated. Dr. Clemmer declares outlet flues are as necessary on gas stoves and grates as they are on furnaces.

"If upon entering the living room or office from the open air there is detected a stuffy, oppressive atmosphere, suspect slow poisoning of the inmates in the presence of the unventilated stove," says the report. Many a funeral, it is declared, comes from the home heated with unventilated gas or oil stoves.

"The essential function of the blood to carry oxygen from the air to all parts of the body to sustain life is diminished for the reason that there is formed a combination between noxious gas and the hemoglobin of the blood. The oxygen-carrying properties of the blood cells are thus destroyed in proportion to the amount of poisonous air inhaled. The victim of the unventilated gas stove may suffer from a dullworking brain and headache, or death may ensue, depending upon how long and how much he breathes the poisoned air."

Some Essentials of Hospital Heating and Ventilation

In the case of hospital heating and ventilation where the wards are heated entirely by indirect heat the quantity of air supplied should, in any case, be so great that the temperature thereof need not exceed 120° F. at any time.

A general rule for air supply and exhaust is to supply air to all rooms into which patients may enter, and also to the corridors, and to exhaust the vitiated air from all such rooms, and from any other rooms which, because of their special use, would make ventilation desirable.

Humidification has been referred to as one of the essentials of good ventilation. Relative humidity and temperature are most intimately associated. It is true that a temperature of 60° or 65° F. with a relative humidity of 50% or 60% is more comfortable and healthful than a temperature of 70% or 75% with a relative humidity of 20%, the latter condition being frequently observed in our homes, schools and hospitals during the winter.

It is not true, however, that the temperature may be lowered and the humidity raised with a resulting saving in fuel, for it takes vastly more fuel to evaporate into the air the amount of water required to raise the humidity than is saved in the 5%, or even 10%, less to which the air is heated. In determining the capacity of the boiler and in considering the fuel consumption, allowance must be made for humidification.

The subject of direct versus indirect heat for hospitals is much discussed. The direct radiators have the advantage of making possible the quicker and less expensive warming up of the rooms upon the closing of the windows and of giving the patients a place to warm feet or hands at such times, the absence of which in rooms without direct radiators is often criticized by doctors.

The amount of direct radiation used in rooms occupied by patients may well be limited to an amount sufficient to counterbalance the heat losses through wall and glass areas. It should not be used in operating and similar rooms.

Some consideration is being given by the medical fraternity to the subject of artificial cooling of hospital wards. In view of the results of recent investigations as to the effect of excessive temperature and humidity it is reasonable to expect that much good may be accomplished in severe cases by lessening the temperature and humidity within the wards in hot weather. There is little available data, however, as to the clinical value of such an arrangement. A combination of a mechanical refrigerating system with an indirect heating and ventilating system for cooling purposes is quite possible.

Recapitulating, the essential features of a hospital ventilating system may be said to be:

Ample natural or window ventilation.

Supplementary thereto an ample supply of fresh air at a low temperature to all rooms used by patients.

System of exhausting the vitiated air from all such rooms.

Special exhaust fan systems for toilets, baths, slop sink and mop closets, etc.

Separate exhaust fan systems for laundry, kitchen, machinery rooms, etc.

The operating rooms may well be separately treated.

Air intake should be located as high as possible.

All air supplied to the hospital should be freed from dust by means of filters, preferably of the washer type.

Air chambers and ducts should be finished smooth, and so far as possible be subjected to light.

Humidification is desirable, and even essential.

Temperature regulation is desirable and a source of economy.

Direct radiation, of a limited amount, is regarded as desirable.—D. D. Kimball, in *The American Architect.*

Possibilities in the Peat Industry

The great peat deposits of the United States seem destined to remain an undeveloped resource, at least for some time to come, not through any effort at conservation, but because of ignorance of their practical value. According to Charles A. Davis, in an advance chapter on the production of peat from "Mineral Resources of the United States," for 1910, which is issued by the United States Geological Survey, noteworthy progress was made in 1910 in the production of peat fuel in other countries than the United States, not only in the quantity actually marketed, but also in methods of production and utilization. In this country, however, although it is generally known that there are large quantities of material good for fuel in the peat bogs and swamps of the nortuern and eastern parts of the country, but little progress has been made in developing this resource on a commercial scale.

In commenting on the growing use of peat in Europe, Mr. Davis refers to its value as a gas producer, the resulting "producer gas" having a recognized high value for fuel and power. In a recently perfected gas producer. it has been found that in converting peat containing a good percentage of nitrogen into gas a large amount of ammonia, greatly valued as a fertilizer, can be obtained as a by-product. Mr. Davis quotes from a report which shows that where gas-producer plants using peat are carefully managed, so great are the profits obtainable that it is often possible, while taking no credit whatever for the value of the power gas, to obtain as much as 100% profit from sulphate of ammonia alone, after making proper allowance for the cost of digging the peat, bringing it to the plant, and for labor, stores, capital, shares, etc. Indeed, with peats comparatively poor in nitrogen, it is possible in many cases to produce the gas for nothing, the cost of power being then merely that of operating the gas engines, together with capital charges on the same.

Although these claims may be somewhat optimistic, says Mr. Davis, it is clear that if each ton of theoretically dry peat gasified yields from 75,000 to 90,000 cu. ft. of producer gas, the calorific value of which is from 125 to 135 B. T. U. per cu. ft., and also gives 200 lbs. of sulphate of ammonia as a by-product, the operation of a plant consuming 10 tons of dry peat fuel a day would produce 1 ton of the ammonia salt. The price of sulphate of ammonia has for some years remained very uniform at about $60 per ton, in spite of enormously increased production.

This process, which is of practical application in the United States, Mr. Davis believes, should be investigated carefully by owners of American peat lands, many of which are very rich in nitrogen, some Government analyses showing as high as 3.39% of combined nitrogen. Peat consumption of all kinds in the United States in 1910 amounted to $182,147. The report on the production of peat in 1910 can be obtained by applying to the Director, United States Geological Survey, Washington, D. C.

A New German Book for Heating Engineers

How must a heating plant be designed in order to show the highest efficiency?—In the first place, the amount of boiler heating surface must be correctly determined—namely, just large enough to cover the heat losses of the building. To determine this, it is necessary to know whether the heating is to be intermittent or continuous. While there is no doubt that some buildings (such as office buildings and churches) should be heated intermittently, it is an open question whether intermittent or continuous heating would be more economical for residences and apartment houses. In the former case, boiler heating surface should be larger than in the latter, because of the absorption of heat by walls, when starting the plant, until the transmission reaches the state of permanency. How large, then, should the corresponding heat losses be figured?—In both cases it appears necessary to deal with pipeline losses. How high should these also be estimated?

All heat losses to be covered being known, the amount of boiler heating surface can easily be found by dividing these losses by the rate of heat transmission per square foot per hour. But how high is this rate under ordinary conditions of actual operation, considering unskilled firing by the janitor or by the so-called useful man? Evidently it should vary, first, with the several types of boilers; secondly, whether these boilers are made of cast-iron or steel, and, in fact, it does vary considerably.

With the boiler heating surface correctly determined, the plant designed and installed, how should the firing be done to obtain the best results with the minimum amount of coal consumed?

These questions, as well as a number of others appertaining to heating practice, find the exhaustive answers in the book entitled "Economy of Centralized Heating" (Wirtschaftlichkeit der Zentralkeizung), written in German by G. de Grahl, M.E., who for many years has been consulted as an expert on heating by German courts. The book is, therefore, largely a statement of facts and results obtained in testing a larger number of heating plants under actual working conditions, and brings out many important conclusions, the knowledge of which should prove of great value to everyone interested in heating.

Not everybody knows, for instance, that the rate of heat transmission of boiler heating surface increases with the increasing rate of combustion only up to a certain point, above which it drops in spite of the fact that the rate of combustion may keep on increasing. Nor is everybody aware of the fact that the highest boiler efficiency (in the neighborhood of 80%, and even higher for certain types of boilers) and, consequently, the highest economy, could be obtained and kept fairly constant during the whole heating period, provided, of course, certain conditions are fulfilled as to the manner of firing. One of these conditions, for instance, is a very low chimney draft, something in the neighborhood of ¼-in. water column. The author of the book states that the highest boiler efficiencies usually were obtained by him at this rate of draft. Another interesting statement of the author is that the continuous heating of dwellings is more economical than the intermittent.

The book, which, as stated, is written in German, has only recently appeared and can be had at $1.50 from the publisher, R. Oldenbourg, Berlin and Munich, Germany.

Notes on Heating and Ventilating, Third Edition, by Prof. John R. Allen, professor of mechanical engineering, University of Michigan, has lately been published by Domestic Engineering, Chicago. In view of the addition of much new matter, bringing the total number of reading pages up to 227, the price of the book has been made $2.50, instead of $2.00. The book is essentially a practical work of present-day methods, although the theory of the subject is sufficiently covered. The author has the faculty of expressing himself clearly, and the conclusions he reaches, together with his many useful hints, gain added weight through his acknowledged standing as an authority on the subject. An entire chapter devoted to central station heating shows the increasing interest this subject is arousing on the part of the heating profession. Pp. 227. Size 6 x 9 in. (standard).

Books Received

Transactions for 1910 of the American Institute of Chemical Engineers. Size 6½ x 9½ in. Pp. 407. Published for the institute by D. Van Nostrand Co., New York. Price $6.00, net.

Domestic Sanitation and Plumbing, by A. Herring-Shaw, Associate Royal Sanitary Institute, London, a treatise of the materials, designs and methods used in sanitary engineering manufacture, jointing and fixing of pipes, sanitary fittings, etc.; removal of waste matter; water supply; hot water services; heating, ventilation, etc. Size 6 x 9 in. (standard). In two volumes (Vol. 1, 318 pages), (Vol. 2, 358 pages). Published in America by D. Van Nostrand Co., New York. Price, $5.00, net.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

New York Chapter Formed

A New York Chapter of the American Society of Heating and Ventilating Engineers was organized October 24 at the rooms of the society in the Engineering Societies Building, New York. Twenty-five signed the roll at that time, and the membership list has since been increased to 34. Annual dues were placed at $5.00 for regular members and $3.00 for juniors. Meetings will be held the second Tuesday in each month at the Engineering Societies Building. Permanent organization was effected by the election of the following officers: President, William M. Mackay; vice-president, James A. Donnelly; secretary, Joseph Graham; secretary-treasurer, Arthur Ritter; board of governors, Frank T. Chapman, H. T. Gates and Frank K. Chew.

Nominating Committee Appointed

At a meeting of the Board of Governors of The American Society of Heating and Ventilating Engineers, September 9, the following were appointed a committee on nominations for officers for 1912: S. A. Jellett, Philadelphia, chairman; Homer Addams, New York; N. S. Patterson, Chicago; F. G. McCann, New York; and J. M. Stannard, Chicago.

The dates for the annual meeting of the society have not yet been decided, but it is probable that they will be January 23, 24 and 25, in the Engineering Societies Building, New York.

Meeting of Test Committee

As a result of a meeting of the society's test committee, composed of James A. Donnelly (chairman), William McKiever, M. F. Thomas, Frank T. Chapman and Nelson S. Thompson, it was decided to undertake three forms of tests on radiators to determine their efficiency with the removal of air as accomplished by ordinary methods and with complete air removal, as in special laboratory tests.

Annual Meeting of Illinois Chapter

New officers were elected at the annual meeting of the Illinois Chapter of The American Society of Heating and Ventilating Engineers, which was the first meeting of the fall season. The election followed a dinner at Vogelsang's, October 9. The newly elected officers are: President, S. R. Lewis; vice-president, J. M. Stannard; secretary, W. L. Bronaugh; treasurer, August Kehm; board of governors, N. L. Patterson, E. F. Capron and George M. Getschow. A minute expressing the chapter's loss in the death of the late James Mackay was read and the board of governors was instructed to incorporate the memorial notice in suitable form and forward it to Mr. Mackay's family.

Institution (British) of Heating and Ventilating Engineers

The programme for the autumn meeting of the Institution of Heating and Ventilating Engineers, which was held in London, October 17, included a discussion of the paper read at the summer meeting by E. R. Dolby, on "Some Doubtful Points in Gravity Hot Water Heating" (published by extract in THE HEATING AND VENTILATING MAGAZINE for August, 1911); also on the paper by Oswald Stott, on "Characteristics of the Propeller Fan" (published by extract in THE HEATING AND VENTILATING MAGAZINE for September). Two papers were presented, one on "Centrifugal Fan Testing," by G. L. Copping, and one on "The Effect of Water Pressure in Preventing the Transmission of Heat Through Surfaces," by President O. M. Row.

Two members of the American Society of Heating and Ventilating Engineers were elected members of the Institution, Thomas Morrin, or San Francisco, Cal., and Nelson S. Thompson, of Washington, D. C. Another member of the American Society, C. R. Honiball, of Liverpool, England, was nominated for president of the British Institution.

National District Heating Association

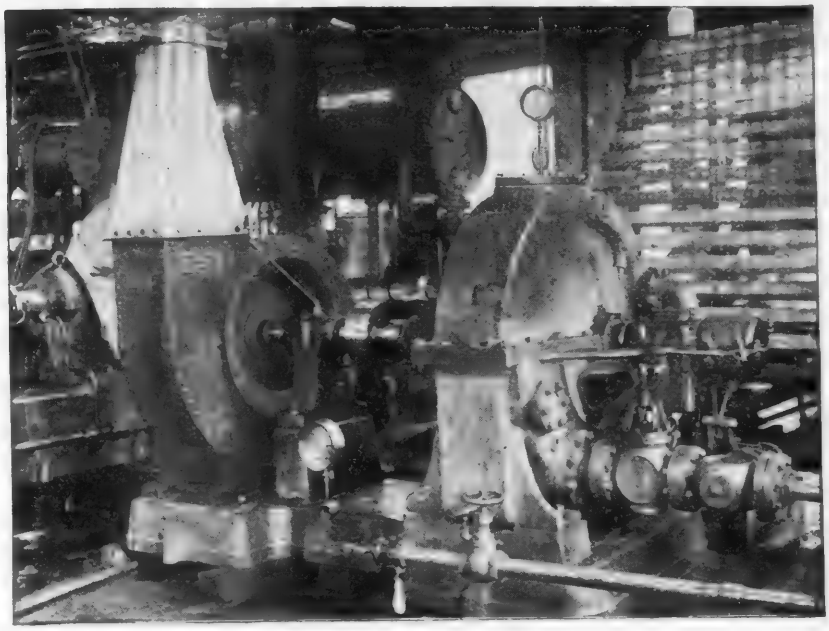
A meeting of the executive committee of the National District Heating Association was called to be held at the Cadillac Hotel, Detroit, Mich., November 8, to fix the time and place for holding the Fourth Annual Convention of the association and to arrange for programme. The committee consists of A. D. Spencer, Detroit, Mich., the president of the association; Warren Partridge, Springfield, Ill., first vice-president; R. D. DeWolf, Rochester, N. Y., second vice-president; Cadwallader Evans, Jr., Pittsburgh, Pa., third vice-president; Geo. W. Wright, Baltimore, Md.; E. J. Keifer, South Bethlehem, Pa.; J. L. Hecht, Chicago, and D. L. Gaskill, Greenville, O., secretary and treasurer.

Test of an Unusually High-Pressure Centrifugal Blower Set

A centrifugal blower delivering air at over 40 in. of water pressure, or nearly 1½ lbs. per square inch, is a new idea to those familiar with centrifugal blowers, which are seldom operated at more than 25 in. of water. At the works of The Terry Steam Turbine Co. a new turbo-blower set was recently tested to see if it would meet the guarantees. The tests of this new design were exhaustive and conducted with great care. This blower set, which consisted of a double-inlet Sturtevant multivane centrifugal blower mounted on the same cast-iron bed with a Terry turbine, and direct-connected by flanged couplings, was to deliver 14,000 cu. ft. of air per minute against a pressure of 40 in. water gauge.

This test was to determine the water rate of the turbine and the closeness of the speed regulation, as well as the volume and pressure of air. During the test, pressure, temperature, and calorimeter measurements were made of the steam just before the governor valve, and the exhaust pressure was measured in the exhaust pipe just beyond the outlet of the turbine. The exhaust steam was taken to a surface condenser and the discharge water from the hot well was weighed. The condenser was vented at the top, so that it would not produce vacuum at the exhaust of the turbine, which was run non-condensing.

To measure the volume of air discharged by the blower, a long tapered cone, having a coefficient of discharge of 0.94, was attached to the outlet, the pressures being taken with a mercury U tube. The blower was to deliver 14,000 cu. ft. of air per minute, but averaged 15,169 cu. ft. for nearly an hour. The steam required for the turbine was not to exceed 7600 lbs. per hour, but during this test steam was used at the rate of 6587 lbs. per hour, or 13.35% less than the guaranteed maximum. The air pressure maintained was to be 40 in. of water, but for nearly an hour this blower averaged 47.3 in., or over 1½ lbs. per square inch. It reached a maximum during a portion of the test of 51.7 in. Consider-



HIGH PRESSURE CENTRIFUGAL BLOWER
SET AS ARRANGED FOR TESTING

Time	Steam Pressure at Throttle, Pounds, Gauge	Steam Pressure at Nozzle Inlets, Pounds, Gauge	Total Water Rate Corrected to Saturated Steam	Speed in R.P.M.	Velocity Pressure Reduced to inches Water	Velocity at Cone Outlet, Feet per Minute	Velocity of Air Deliv'y, Cubic Feet per Minute	Horse-Power for Delivering Air, Actual
2:10	140	103		2480				
2:13			6200					
2:15	131	103		2470	47.6	27000	15220	114.1
2:16			6560					
2:19			7000					
2.20	145	105		2480	48.95	27350	15400	118.6
2:22			6840					
2:25	145	105	6800	2480	47.6	27000	15220	114.1
2:28			6780					
2:30	135	102		2440	46.2	26600	15000	109.1
2:31			6525					
2:34			6475					
2:35	150	106		2480	51.7	28100	15850	129.
2:37			7340					
2:40	148	101	6600	2450	46.2	26600	15000	109.1
2:43			6365					
2:45	128	100		2445	46.2	26600	15000	109.1
2:46			6280					
2:49			6520					
2:50	153	102		2450	46.2	26600	15000	109.1
2:52			6530					
2:53	150	101	6610	2460	46.2	26600	15000	109.1
2:58			6310					
3:00	150	100		2460	46.2	26600	15000	109.1
3:01			6240					
Average	145	102.5	6587	2463	47.3	26900	15169	112.6

ing the excess in both volume of air and the pressure at which it was discharged, the blower set delivered 27.5% more work than was called for.

Reducing the guaranteed conditions to steam consumption per horse power for delivering air, gave a result of 58.5 lbs. as against the guarantee of 86.13 lbs. The accompanying table gives more in detail the important readings made during this test.

A separate test to determine the speed gave the following results: The turbine was operated at 2490 R. P. M. without load; with full load thrown on momentarily the speed was 2400 revolutions, and with the full load soon settled to 2460 R. P. M. This shows that the momentary speed drop was 3.6% and the settled drop only 1.2%. While the blower was running under full load at 2460 R. P. M., the gate was closed suddenly; the speed momentarily jumped to 2575 R. P. M., or 4.7%, but it quickly settled to 2490 R. P. M., or an increase of 1.22% over that at full load.

The suitableness of the steam turbine of this type for the direct-connected driving of high pressure blowers was made evident from these results. The high pressure and closeness of speed regulation were made possible by having the governor mounted directly on the turbine shaft. In this way onlv, it is said, can possible failure of intermediate gear be eliminated. The direct-connected governor, running at turbine speed, was shown by the tests to be very powerful and highly sensitive.

A New Line of Back Pressure and Atmospheric Relief Valves

Apropos of an article on another page of this issue on the operation of back pressure and atmospheric relief valves, a remedy for the various troubles experienced has been found in the use of a multiplicity of disks, instead of one disk. The development of this idea is shown in the accompanying illustrations. Heretofore such a construction has presented insurmountable difficulties to designers of such valves, probably because the means ordinarily employed for holding the disks of back-pressure valves to their seats are not suitable where there are a number of small disks instead of one large disk—that is, it would be difficult to load a large number of separate disks independently by means of weights without greatly complicating the apparatus, and if springs were to be used, means were not available for adjusting the several springs accurately and simultaneously for different back pressures.

The valve shown herewith may be described briefly as consisting of a valve deck upon which are placed a multitude of small valve disks, each individual small disk having a spring to hold it closed, a water cushion or dash pot to arrest its motion and prevent damage to the disk and its seat, and a stem by means of which it may be lifted free of the seat when desired. The tension of the spring is determined by the position of a pressure plate, adjustable by means of a vertical screw, which may be turned one way or the other by means of bevel gears connecting with a horizontal shaft which extends to the exterior of the valve casing, and is fitted with a hand wheel, chain wheel or gear wheel, as circumstances may dictate. The valve deck is placed between the flanges of the bottom and top castings, the latter having two or more hand-hole plates or doors for access to the valve deck.

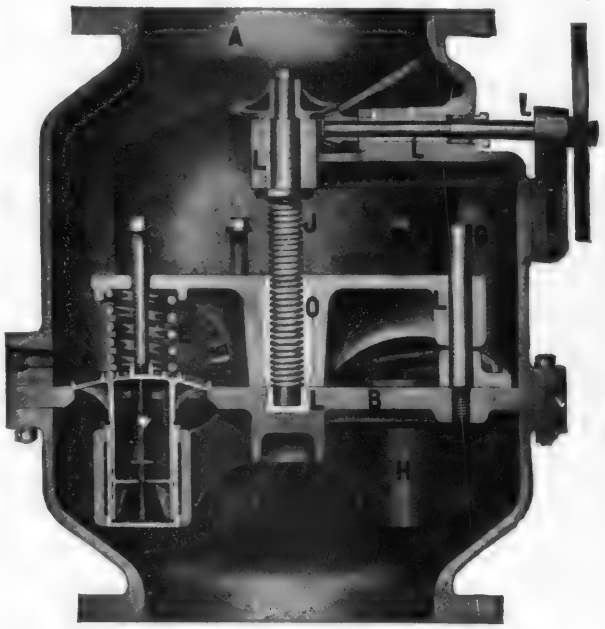


FIG. 1—COCHRANE MULTIPORT SAFETY EXHAUST OUTLET VALVE

A—Casing
B—Valve Deck
C—Pressure Plate
D—Valve
E—Springs
F—Valve Stems
G—Guide
H—Dash Pot
I—Dash Pot Lining
J—Spindle for Raising and Lowering Pressure Plate
K—Gears
L—Bearings—Babbitt
O—Nut--Babbit or Bronze

From the type of valve disks used, their large number, and the fact that they are made of bronze, as are also the linings of the dash-pot, it will be seen that the probability of sticking is exceedingly remote. Even, however, in case one disk should be deranged, or for any other reason refuse to leave its seat, all the other disks will continue in operation, so that the possibility of all disks of a valve becoming inoperative at one time is exceedingly remote, in fact almost infinitesimal.

The gain in effective discharge area through the use of the small disks is considerable. As an example, let us take a

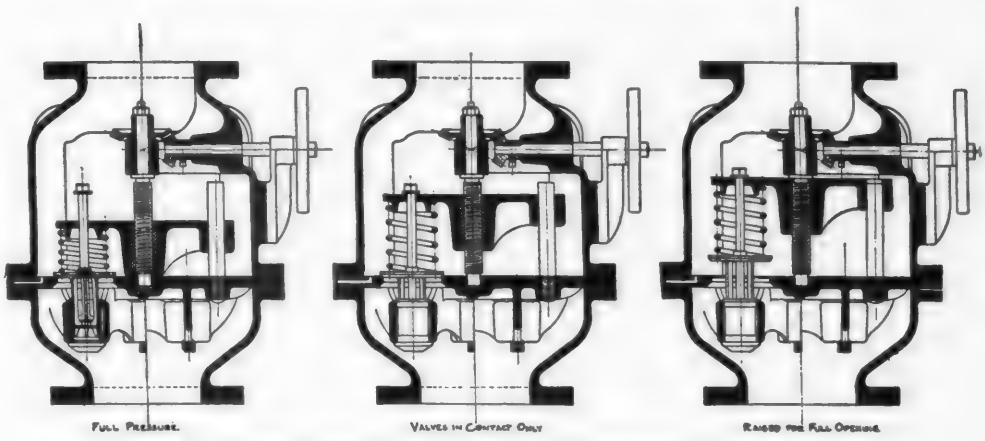


FIG. 2—ARRANGEMENT OF VALVE WITH PRESSURE PLATE SHOWN IN THREE DIFFERENT POSITIONS

10-in. valve. With a single disk, the area of the valve would be 78.7 sq. in., while the periphery of the valve or length of valve seat would be 31.4 in. If the area of this valve were distributed among six small disks, each would have an area under the disk of 13.1 sq. in., and a length of valve seat of 12.8 in., and since there are six disks, the total length of valve seat would be about 77 in., or over twice as much as in the case of the single disk having the same area. It follows from this that the small valve will need to rise less than one-half as far as the large valve in order to discharge the same amount of steam with the same back pressure. As a matter of fact, in the valves here shown the aggregate area of the small disks is somewhat larger than the areas of the circle corresponding to the size of the valve, in order to provide an unrestricted passage for the steam when the disks are raised for exhausting free to atmosphere.

As the individual disks are small and light, and have only a small lift as compared with a large disk, and are held to their seats by springs instead of weights, the total mass in motion when the valve disk closes is comparatively small, so that the small disks are not only quick to respond, but strike their seat with much less force per lineal inch than does the large disk held down by a weight. The seating of the disks is retarded by cushions of water in the dash-pots beneath the disks. It is found that there is always water in these dash-pots, due to the condensation of the steam, but where dash-pots are inverted, as in some types of valves, they will contain only steam or air, which is not as effective in arresting the motion of the plunger as is water.

An important advantage of this design of valve is found in the means for adjusting the tension of the springs. This may be done by raising or lowering the pressure plate. At the same time, it is impossible for a certain pressure to be exceeded without substituting new springs—that is, when the pressure plate is down all the way, the springs are compressed to the maximum extent.

The illustrations show both the ordinary back-pressure valves, intended for exhaust steam heating, drying and similar service, and valves for vacuum service. The latter differ chiefly in the use of lighter springs, and in provision made for water sealing. The water seal may be of the simple overflow type,

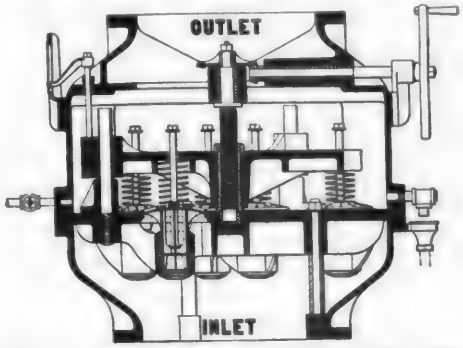


FIG. 3—ARRANGEMENT OF VALVE FOR VACUUM SERVICE, SHOWING OVERFLOW TYPE OF WATER SEAL

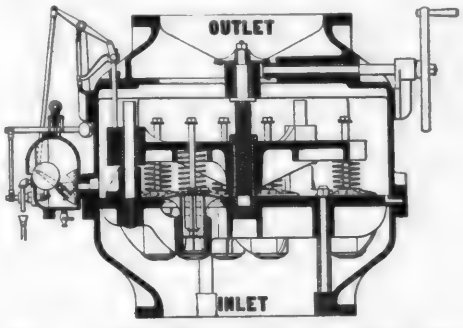


FIG. 4—ARRANGEMENT OF VALVE FOR VACUUM SERVICE, SHOWING TRAP-CONTROLLED WATER SEAL

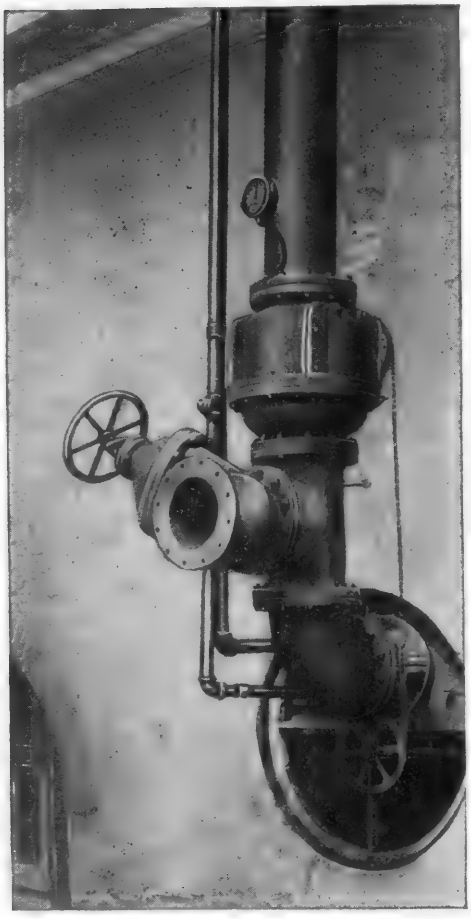


FIG. 5—TYPICAL INSTALLATION OF COCHRANE MULTIPORT SAFETY EXHAUST OUTLET VALVE

shown in Fig. 5, the water entering through the valved connection at the left, and overflowing at the right; or it may be of the trap-controlled type, shown in Fig. 6, which is more economical of water, since, when the water reaches the required depth on the plate, the further admission of water is cut off by the float in the float chamber. In order to prevent waste of water when the valves are raised for exhausting free to atmosphere, a system of levers is provided which closes a valve in the supply pipe. As shown in Figs. 5 and 6, an indicator is provided on the outside showing when the disks are fully raised or closed.

The three drawings in Figs. 2, 3 and 4 illustrate the several positions of the pressure plate and valve disks when the valve is set to the maximum back pressure, when set with the valve disks just touching the seat, as when only a few ounces of back pressure are required to force steam into heaters or other apparatus, and finally with the valves raised to the maximum height to allow free exhaust to atmosphere.

The type of valve herewith described and illustrated is known as the Cochrane Multiport Safety Exhaust Outlet Valve, and is manufactured by the Harrison Safety Boiler Works, 3189 North 17th street, Philadelphia, Pa., to whom we are indebted for the information and illustrations used. This company also controls patents fully protecting the several novel features involved.

The Rennert Automatic Electric Regulating Devices

Automatic electric appliances for regulating boiler feed, for controlling ventilators, pumps, etc., and for maintaining even temperatures in hot-water tanks, are among the interesting devices that have recently been perfected by Otto Rennert & Co., Munich, Germany. In addition to the uses stated, the company's appliances are designed to control boiler dampers, mixing valves for baths, etc., gas burners, and reducing valves.

Typical uses of the Rennert devices are shown in the accompanying illustrations. Fig. 1 shows the arrangement for regulating the temperature in a hot-water tank. The valve for plants with high pressure is operated by an electric-driven motor. Where low-pressure steam is used, the valve is operated by magnetic

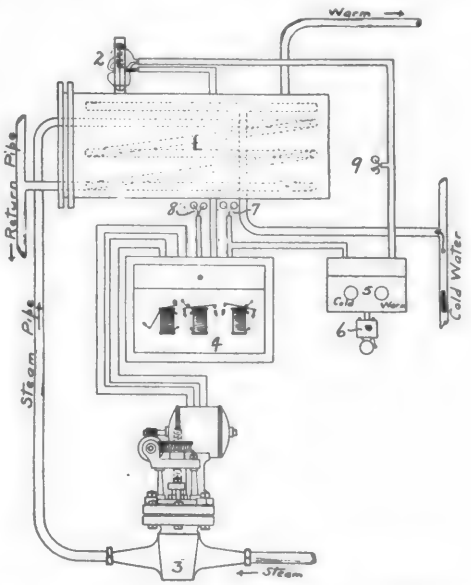


FIG. 1 — ARRANGEMENT OF AUTOMATIC ELECTRIC TEMPERATURE REGULATING APPARATUS FOR WATER TANKS

1—Water Tank
2—Thermometer
3—Steam Supply Valve
4—Switch Board, with Relays Operating Steam Valve
5—Indicator Board
6—Alarm Bell
7—Connection for Open Circuit
8—Connection for Closed Current
9—Open Circuit Connection to Operate Indicator Board

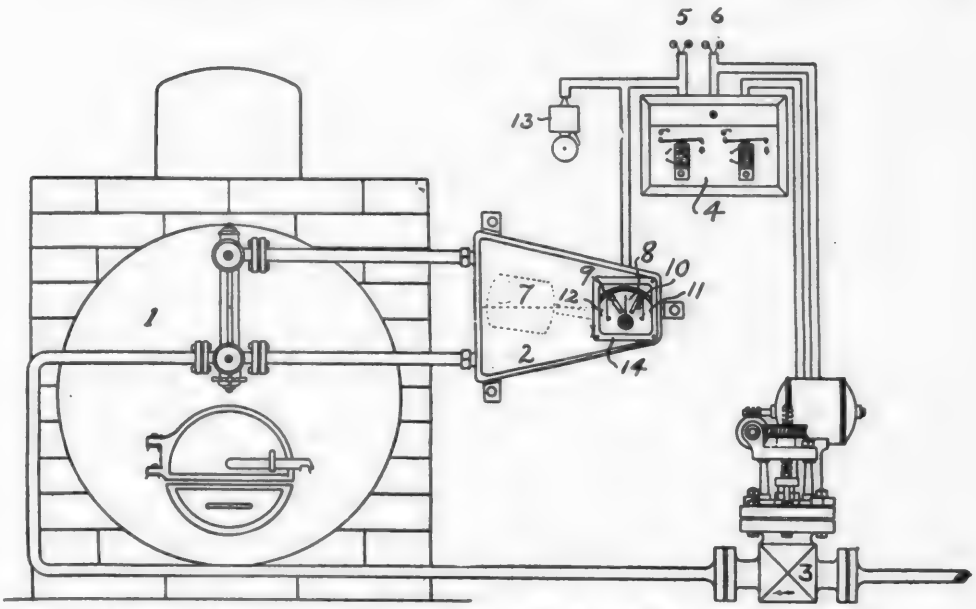


FIG. 1—ARRANGEMENT OF AUTOMATIC ELECTRIC BOILER FEEDER

1—Boiler
2—Water Gauge Controlling Device
3—Boiler Feed Valve
4—Relay Box
5—Connection for Closed Circuit
6—Connection for Open Circuit
7—Water Float
8—Rotary Axis Hand
9-10—Adjustable Contacts
11-12—Safety Contacts
13—Alarm Signal
14—Glass Case

levers. In either case, the general arrangement is the same. The hot-water tank is shown at (1). The hot-water thermometer (with its platinum contacts) is shown at (2). The steam supply valve (3) is attached to an electric-driven motor. The switch-board with its relays, by means of which the steam valve is opened and closed, is shown at (4). These relays are operated through the closed circuit wire (8). The motor for the steam valve is operated through the wire (7). The indicator board is shown at (5) operated through the open circuit wire (9). The indicator board has an electric alarm bell (6) which rings in case of trouble.

Fig. 2 is an automatic electric boiler feeder. The float (7) indicates the water level in the boiler. This float operates the dial (8), which may move either way. When the water level goes down, the dial makes contact at (9), and when the higher water level is reached the dial makes contact at (10). When contact is made at (9), through its connection in the relay box, the feed valve is automatically opened. On the other hand, the feed valve closes when the dial makes contact at (10). The alarm signal (13) is used to safeguard the plant against any unusual disturbance.

These, as well as the company's devices, are the subject of an interesting catalogue recently published by the manufacturers.

Steam Distribution in Radiators with the Modulation System

There has always been a great deal of doubt as to the nature of the steam distribution in radiators equipped with a fractional valve on the supply and an automatic water and air relief valve on

RADIATOR 3HOWING SPACE OCCUPIED BY STEAM WHEN VALVE INDICATOR IS AT FIRST OPENING

the discharge. Recent tests made by Warren Webster & Co., Camden, N. J., show that when the features of the Modulation system are used there is a well-defined portion of the radiator supplied with steam while the rest is cool.

In the Modulation system, on the supply end is a modulation valve capable of

being opened in proportion to the amount of heat needed for a comfortable temperature, the index dial showing the degree of opening. On the return end is placed an automatic water and air relief valve which, as its name implies, automatically relieves the radiator of condensed steam and air, but prevents the escape of steam.

As the automatic discharge valve is connected with a return open to the atmosphere, it appears that when the supply of steam is reduced the air backs up into the radiator, and, being heavier than the steam, occupies the lower portion of the radiator, reducing the temperature below that of the upper part.

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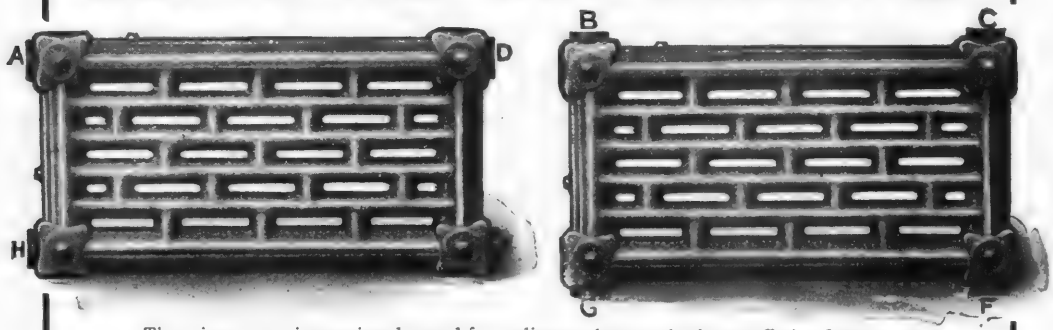
OUT OF THE WAY RADIATORS



There is an ever-increasing demand for radiators that can be hung off the floor on wall or ceiling, placed in skylights, and still be practical, efficient heating surfaces.

No radiator made adapts itself better to space-saving conditions than the ATHENIAN WALL PATTERN of United States Radiators. Used in factory buildings where space is most valuable, in churches and schools, under windows to stop cold air currents, in assembly halls, stores, garages and all buildings where radiation should be off the floor.

The ATHENIAN WALL PATTERN is a most efficient wall radiator. Made in three sizes, connected with extra heavy right and left hand inside nipples. Has cross-bar circulation which increases its heating value, giving more efficiency than can be had in any other pattern of wall radiator.

Assembled in all shapes at the factory which saves labor cost on the job and they can easily be used in odd corners and out of the way places where regular radiation would be impossible.

It seems to us that you must be interested in this modern space-saving radiator, and we have prepared for your benefit a booklet that illustrates and describes in full the special advantages of this OUT OF THE WAY RADIATOR. It's free—Write for it to-day.

UNITED STATES RADIATOR CORPORATION

GENERAL OFFICES. DETROIT, MICH.

BRANCHES IN PRINCIPAL CITIES

Makers of more styles of radiation than any other individual manufacturer

TRADE AND MISCELLANEOUS NOTES

Coming Events

Second Tuesday in Each Month.—Meeting of the New York Chapter, American Society of Heating and Ventilating Engineers, Engineering Societies Building, 29 West 39th street, New York.

December 5-8, 1911.—Annual meeting of the American Society of Mechanical Engineers, New York. Headquarters at the Engineering Societies Building.

January 23-25, 1912.—Probable date of Annual Meeting of American Society of Heating and Ventilating Engineers. Headquarters at the Engineering Societies Building.

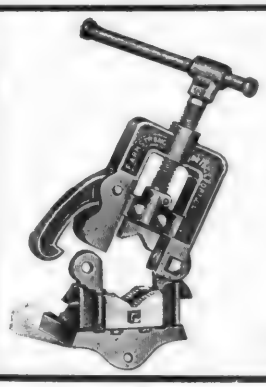
Miscellaneous Notes

Des Moines, Ia.—The Des Moines Central Heating & Power Co., organized in 1891, and granted a franchise by the city during that year to lay mains in the streets of Des Moines, will rebuild its plant, lay new mains and again open for business, according to a communication filed by W. H. Schott, president of the new company, with the city clerk. The territory bounded on the east by the Des Moines river, on the west by Tenth street, on the north by Chestnut street and on the south by Market street, will be served. Oronda H. Davison, vice-president of the Standard Life Insurance Company, is understood to be one of the principal stockholders in the new enterprise.

Peoria, Ill.—Suit has been brought by Albert G. Sherer, of Chicago, against F. Meyer, Brother & Co., Peoria, Ill., manufacturers of heating apparatus, on the ground that certain parts of the company's heating apparatus and the fittings thereof were claimed to be patented when in reality they were not covered by patents. The penalty for the violation of the statute covering this point is $100 for each offense. There are 4117 counts in the present charge, filling 3000 sheets of typewritten manuscript. Conviction on all counts would mean a total fine of $41,170, of which the plaintiff would get one-half.

Louisville, Ky.—An ordinance has been introduced before the general council of the city at the instance of the Kentucky Electric Company, under which a franchise for the manufacture and sale of steam heat in the central districts of the city is provided for. The proposed ordinance states, among other things, that the smoke emitted from the stacks in the congested districts is a menace to health, as well as the cause of much dirt, and suggests a central plant for the manufacture of steam as a means of doing away with these conditions. The streets that would be covered by the heating system are Third, from Washington to Market; Fourth, from Main to Walnut; Fifth, from Main to Jefferson; Center, from Jefferson to Green; Washington, from First to Third; Main, from Third to Seventh; Market, from Fourth to Fifth; Jefferson, from Second to Fourth and from Fifth to Sixth; Green, from Third to Fourth; and Walnut, from Third to Fifth. The plant is expected to cost $450,000. Where steam heat is sold on a flat rate, the rate is to be 35c. per square foot. The meter rates are to run from 90c per 1000 lbs. for amounts under 5000 lbs. per month for each 100 sq. ft. of required radiation, to 45c. for amounts over 5000 lbs. per month.

Anderson, Ind.—The city council has granted a steam heating plant franchise



ARMSTRONG MALLEABLE IRON HINGED VISES.

No. 0	Holds Pipe	⅛	to 2½	in.	11	lbs. each
No. 1	" "	¼	" 2½	"	16	" "
No. 2	" "	½	" 4½	"	30	" "
No. 3	" "	1	" 6	"	35	" "

Crucible Steel Jaws, All Parts Interchangeable

Catalog mailed on request

MANUFACTURED BY

THE ARMSTRONG M'F'G CO.

321 Knowlton St.

NEW YORK **BRIDGEPORT, CONN.** CHICAGO

for a period of 25 years to Otis P. Crim, of Indianapolis. The Anderson Trust Company, in control of the plant of the defunct Home Heating Company, had applied for the franchise, and it was agreed to grant it to the Anderson Trust Company until the trust company was advised by the auditor of the State that a trust company could not accept a public franchise. The trust company proposed, however, to assign the franchise to Mr. Crim, who has bought the plant of the Home Heating Company, which went into receivership some time ago, and arranged to operate the same beginning in October, and promises to rebuild the plant next year. Mr. Crim's company will charge by meter rate at 65c for the first 100,000 lbs. condensation, the prices ranging downward from that point to 45c for 300,000 lbs. or more.

Baltimore, Md.—Judge John C. Rose, in the United States Circuit Court, rendered a decision October 13 in favor of the Government in its dissolution suit against the Standard Sanitary Mfg. Co. and others forming the so-called "bathtub trust." Judge Pritchard concurred in the decision, while Judge Goff dissented. This case is separate from the criminal action against the alleged trust being tried in Detroit against the same defendants.

Plumbing and Heating Magazine is the title of a new trade journal published by a number of Philadelphia jobbers of heating and plumbing supplies. The new periodical, it is stated, is not intended to compete with any of the established trade journals, being intended to foster the interests of the jobbers in the territory covered by the journal, and to bring about a better understanding between jobbers, manufacturers and plumbers. The journal is issued bv the Commerce Publishing Co., 505 Arch street, Philadelphia, and its editorial committee consists of J. Harvey Borton, of Haines, Jones & Cadbury Co.; E. S. Thompson, of the Haynes-Thompson Co.; Walter Walls, of Walls, Owen & Stambach Co. The publication committee consists of F. W. Dows, of the Keystone Supply & Mfg. Co.; F. H. Shuster, of the Shuster Plumbing Supply Co.; and John F. Fleck, of Fleck Bros. Co. The advertising committee consists of John G. Fleck; William Froelich, of Froelich Bros; and C. J. Rainear, of C. J. Rainear & Co.

Eastern Supply Association, at its quarterly meeting, in New York, October 11, elected the following officers for the ensuing year: President, P. M. Beecher, Pierce, Butler & Pierce Mfg. Co., Syracuse, N. Y.; first vice-president, John A. Murray, John A. Murray & Co., New York; second vice-president, F. H. Locke, Locke, Stevens & Co., Boston; secretary, Frank S. Hanley, New York; treasurer, Martin Behrer, Behrer & Co., New York. An interesting talk on "Credits" was given by Daniel L. Hansom, of Petersham, Mass.

Arthur D. Little, Boston, chemist and engineer, has been elected director in the Standard Alcohol Co., New York. This concern has been organized with a capital stock of $12,500,000 to manufacture ethyl alcohol from waste wood.

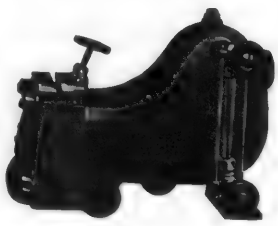
KEEPS JOINTS TIGHT

That's what Dixon's Pipe Joint Compound does and yet permits easy disconnection whenever this is desired.

JOSEPH DIXON CRUCIBLE COMPANY Jersey City, N. J.

McDaniel Improved Steam Trap

WILL DO THE WORK



When you need a Steam Trap buy one you know will work. With a McDANIEL we take all the chances. Don't pay until you are satisfied. We have been 25 years manufacturing Steam Traps and know there is no better trap made. May we send you one for trial?

Watson & McDaniel Co.

160 North 7th Street - PHILADELPHIA, PA.

Send for Catalogue

Manufacturers' Notes

Crane Valve Co., Bridgeport, Conn., is building a new pattern storage building. The construction will be of brick, with steel trusses and cement tile roof. The building will occupy a site 353 ft. by 50 ft., and will be one story high, with the trusses of sufficient strength to carry monorail travelers for handling heavy patterns. The building was designed by the Hopper-Falkenau Engineering Co., New York.

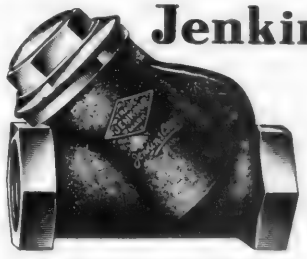
Spencer Heater Co., Scranton, Pa., is building a one-story addition to its plant. The new building will be 40 ft. by 87 ft., of brick and wood construction.

American District Steam. Co. announces the removal of its general offices from Lockport, N. Y., to its new works at North Tonawanda, N. Y. The company is sending out a handsomely engraved notice of the change, together with a cordial invitation to the trade to visit its new plant at North Tonawanda.

Ilg Electric Ventilating Co., Chicago, Ill., has established a New York branch at 13 Park Row, in charge of George Breidert, an experienced expert on fan work. The branch office will carry a full line of the company's fans and blowers and will be equipped to make prompt deliveries.

Garden City Fan Co., Chicago, Ill., has made arrangements with the L. J. Wing Mfg. Co., 90 West street, New York, to act as its eastern representatives. The company has also opened an office in Birmingham, Ala., in the Woodward Building.

Carrier Air Conditioning Co. of America, Buffalo, N. Y., reports that the boards of education throughout the country are gradually realizing the possibilities of obtaining pure air for school children by mechanical means. Some of the more recent installations of the Carrier air washing apparatus made by the company are School No. 20, Rochester, N. Y.; the Fairbanks, Rose and Bennett Schools, Detroit, Mich.; Girls' High School, Louisville, Ky.; Lewis and Clarke High School, Spokane, Wash.; Northwest Grammar School, Philadelphia, Pa., and the Ohio Mechanics' Institute, Cincinnati, O. Canada is not far behind in these installations, and the same company reports the following installations, embracing territory from coast to coast: Brooklyn School, Winnipeg, Man.; two school buildings in Saskatoon, Saskatchewan; George Jay School, Victoria, B. C.; Student Union Building, and the Engineering Building, McGill University, Montreal, and five public schools in Montreal.



Jenkins Bros. Check Valves

are made from Standard and Extra Heavy pattern, both brass and iron body, in several different styles—horizontal, angle, vertical, swing. All are fitted with the Jenkins Disc, thus assuring a tight seat. And as the Jenkins Disc takes practally all the wear, the seat is seldom injured, and valves give long and satisfactory service without requiring attention or repair.

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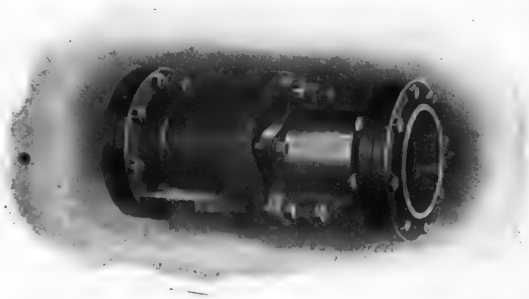
JENKINS BROS., New York, Boston, Philadelphia, Chicago



High Grade Expansion Joints

We manufacture expansion joints for inside, outside and underground work. In all sizes from 1 to 30". Our experience covers a period of over thirty years. Let us figure on your requirements.

Write for Bulletin 104

American District Steam Co.

North Tonawanda, N. Y. Chicago, Ill.

Trade Literature

Capitol Automatic Expansion Tanks, made by the United States Radiator Corporation, Detroit, Mich., are called to the attention of the trade in new circular matter, emphasizing among their advantages that they always keep the system full of water, require no attention on the part of the owner, are sightly in appearance, prevent freezing in exposed locations, and require neither gauge glass nor altitude gauge. The tanks are made of hardwood, lined with copper and furnished with cast-brass trimmings.

Graphite, for October, 1911, the monthly publication issued by the Joseph Dixon Crucible Co., Jersey City, N. J., contains, among other things, a page of photographs of the company's Boston sales force, H. A. Nealley, manager. One of the salesmen in the Boston office, A. K. Ingraham, holds the unique position of being one of the oldest salesmen in the country. An interesting article on "Purity of Graphite" takes up the matter of the carbon percentage of Dixon's various grades of graphite. To the question, "What is the difference between graphite and carbon?" the only answer, it states, seems to be that "graphite is soft and unctuous, while carbon is hard and has no unctuous feeling." The article goes on to explain why it is difficult to make a satisfactory reply as to the carbon percentages of graphite.

Radiation for September, 1911, published by the United States Radiator Corporation, Detroit, Mich., continues the interesting serials which began in the August issue on "Heating Buildings with Steam," by Roufis St. John, the present installment taking up continuous steam and return mains, divided circuit mains and down-feed or drop-riser systems; also "The Story of the Match," by George E. Walsh, and "Fuel and Draft," by James J. Cosgrove, continuing his discussion of the classification of coals. Other notable articles in this issue are "The Eskimos of the South," by Charles Wellington Furlong; "Some Recent Installations in Lyons, France; and "How Coke Is Made," by E. I. Farrington.

J-M Packing Expert for September, 1911, the interesting house organ of the Cleveland, Ohio, office of the H. W. Johns-Manville Co., is made a special fall covering number and is enlarged to include descriptions of the company's line of coverings for the factory, the home, and for other uses. The illustrations show a battery of heaters and pipes properly covered with J-M asbestocel blocks and cement for the heater and J-M asbestocel sectional covering for the pipes; also the municipal garbage reduction

THE VALVE THAT WORKS

89 Mowell Automatic Relief Valves are installed in the Doherty Silk Mill, in Paterson, one of the most up-to-date plants in the country and THE SYSTEM WORKS PERFECTLY

Send for descriptive matter, telling how the Mowell Automatic Relief Valve is suited to Exhaust and Low Pressure Steam Heating, how it expels all air and water from the radiator and how easy it is to keep clean.

Augustus Mowell

249 Graham Avenue, PATERSON, N. J.

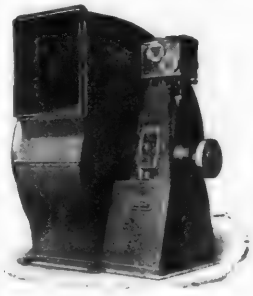
plant in Columbus, O., and the boiler and engine rooms of Corrigan, McKinney & Company's furnace in Cleveland, O.

J-M Roofing Salesman for October, published by the H. W. Johns-Manville Co., New York, contains an illustrated description of "A Twentieth Century Garage," of A. F. Holden, in Cleveland, O. The garage was built on the ruins of one destroyed by fire, and the views presented of the carriage room show the walls and ceiling covered with J-M asbestos wood, ¼ in. thick, and 3-in. wide J-M asbestos wood batten strips over all joints. All windows and door casings are made of 1-in. thick J-M asbestos wood.

Powers System of Temperature Regulation is the subject of a handsome new catalogue published by the Powers Regulator Co., Chicago, Ill. In addition to an exhaustive description of the Powers devices, with new and well-executed plates, the catalogue contains typical layouts of indirect heating systems, properly equipped with the Powers system, showing each installation in detail. An additional layout shows a heating layout with humidity control, equipped with the Powers hygrostat. Twenty pages are taken up with views of more important buildings containing installations of the Powers temperature regulation system. Pp. 40. Size 7 x 10 in.

American Rotary Valve Company's line of vacuum and compressed air machinery for cleaning, sweeping, scrubbing and disinfecting, is described in a new catalogue issued by the company, whose headquarters are at 56-58 Dearborn street, Chicago, with a New York office in the Metropolitan Building. The company is at present installing the vacuum cleaning plant for the new post-office building at the Pennsylvania Railroad Terminal in New York, and the catalogue shows types of the steam-driven vacuum machines used in this installation, as well as many detail views of this and other types. The company has many important installations to its credit in the west, as illustrated by typical views of buildings it has equipped. Pp. 32. Size 6 x 9 in. (standard).

Hot Blast Heating and Ventilating Outfits are exhaustively discussed in a 94-page book bearing the title "Heating and Ventilating," in which the Green Fuel Economizer Co., Matteawan, N. Y., has brought together the information required for the designing and proportioning of hot-blast outfits for heating, ventilating, drying, etc. The book contains some two or three dozen tables of temperatures required in rooms for various purposes; heat transmission through building materials; heat given off by occupants and by lights; standard sizes



The Sturtevant Multivane Fan

The most efficient commercial Fan in the world.

Occupies less space than any other type and can be built to run at the highest speed.

It is carefully designed and rigidly constructed.

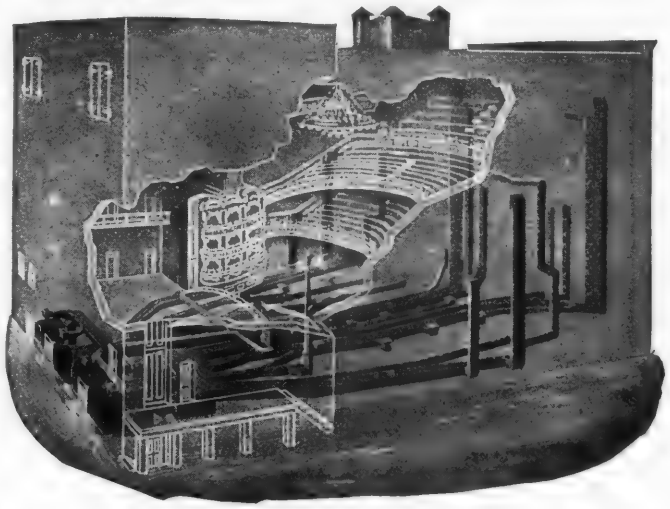
Our Engineers will make recommendations to meet specifications or suggest the best method of installation.

B. F. STURTEVANT CO.

HYDE PARK, MASS.

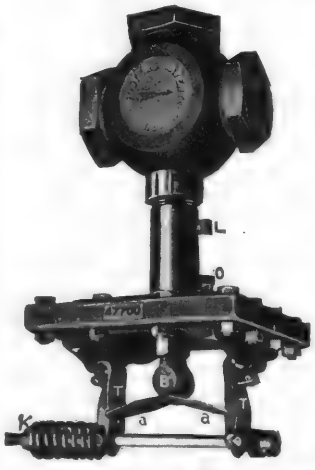
Ask for Catalog 180 V. 831 Offices in principal cities

of hot-blast heaters; frictional resistance of air washers; relative humidities; humidities and temperatures throughout the United States; amounts of air required for ventilation; equivalent air pressures, velocities and horse powers; total weight of air at various barometers and temperatures; pressure and power consumed in friction; speed, capacity and power of steel plate fans; friction of air through hot-blast coils, etc. The text takes up not only the usual details relating to the construction of fans, heaters and heating ventilating systems, but also the calculation and designing of piping systems, giving for the latter two methods differing somewhat—viz., that used in the office of the Supervising Architect at Washington, and that proposed by Rietschel and covering the resistance of sheet-iron pipes and of angles, bends, branches, grills or registers, etc. There is also a chapter on the loss of head of air flowing through orifices and equivalent orifices, in which is presented a method of combining the resistances of ducts in parallel and series connections analagous to the Ohm's and Kirchoff's laws for electrical circuits. Another chapter gives the result of an extensive series of tests upon Green's Positiv-flo steam heating coils, by means of which



GREEN SYSTEM OF HEATING AND VENTILATION FOR THEATRE, WITH INDEPENDENT SYSTEM FOR STAGE

PRESSURE REGULATORS FOR STEAM HEATING



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A very sensitive and reliable regulator for purposes designed. It is a high grade low pressure regulator. Superior to other makes in construction and workmanship. Has no weights or close fitting pistons and is easily adjusted to pressure desired between zero and 15 pounds.

Made in sizes ¾-inch to 12 inch. Smaller sizes 2-inch and under, are fitted with brass bodies; larger sizes have iron bodies, composition mounted and composition *renewable seats.*

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heaters of suitable sizes may be selected for any given duty. The general illustrations of the book include not only views of buildings equipped with heating and ventilating apparatus built by the Green Fuel Economizer Co., but also detailed plans, elevations and "ghost" views showing the actual arrangement of the fans, heaters, piping, outlets, etc. Copies of this book will be sent upon requests to architects, heating and ventilating engineers and others concerned with the purchase, design or operation of heating plants.

For Sale

For sale, patent rights for the Wizard Valve Fitting, illustrated and described in the October issue of this journal. It is one of the most valuable inventions ever devised for one-pipe steam heating systems. For further particulars, address J. J. Wilson, consulting engineer, 917 North 66th street, Philadelphia, Pa.

Business Troubles

Neiman Mfg. Co., New York, manufacturers of hot water heating apparatus, has had two executions filed against it in favor of Jay L. Adams, Jr., for $7378, and Simeon F. Sullivan, for $431. The company is a Delaware corporation, organized in 1910. President, Jay L. Adams; treasurer, Simeon F. Sullivan.

Canton Foundry & Heating Co., Canton, O., has failed with liabilities at $11,582 and assets at $130,754. An item of $80,000, listed in the assets, is given as the value of the patents owned by the concern.

New Firms and Business Changes

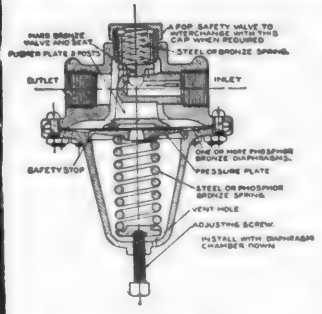
Arthur M. Alvord, 25 West 42nd street, New York, has opened a contracting office for steam and hot water heating.

Merchants' Heat and Light Co., Chicago, has increased its capital stock from $500,000, all common, to $3,000,000, of which $1,000,000 is common and $2,000,000 preferred. Of the new stock, $500,000 will be issued at this time.

Hays Plumbing Co., Morristown, N. J., is the new title of the business heretofore conducted by Tompkins & Welsh, of that place. The business was purchased by Joseph A. and William B. Hays.

D. M. Quay has opened an office in the Williamson Building, Cleveland, O., as consulting and contracting engineer for the mechanical equipment of buildings.

Wilson Pipe Covering Co., Grand Rapids, Mich., manufacturer of coverings for underground piping, has increased its capital stock from $5,000 to $30,000.



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For Water, Steam, Air, Oil, Gas, Etc.

Single Seat Type, 13,160

This valve is for pressure reduction and regulation in the following kinds of service:

WATER—Cold or hot water in hotels, apartment houses, residences, factories, drinking fountains, breweries, power plants, etc.

STEAM—Radiators, small heating systems, small vulcanizers, small bleaching keirs, jacketted kettles, dryers, dyeing tanks, steam heating of trains, forced draft blowers, fan engine regulators for boilers, etc.

AIR—Pneumatic tools, oil burners, pneumatic water lifts, ballast tanks, torpedo discharge tubes, etc.

OIL—Fuel oil, pressure lubricating systems, etc.

GAS—Carbonic acid gas in soda fountains, breweries, water carbonating and bottling establishments, etc. Special valves for oxygen, acetylene, manufactured or natural gas.

Standard stock valves will be assembled for initial pressures up to 250 pounds and for such delivery pressure as specified from atmosphere to 150 pounds.

When writing please specify initial and delivery pressure and service.

H. MUELLER MFG. CO.

DECATUR, ILL., West Cerro Gordo Street NEW YORK, 254 Canal Street

Hayes Bros., Indianapolis, Ind., heating and ventilating contracting engineers, are building a new two-story building at 26-28 West Vermont avenue, which they will occupy when completed. The new building is 150 ft. deep.

J. D. Hull, 621 Colman Building, Seattle, Wash., has opened an office in that city as a contracting engineer for heating and ventilating plants.

New Incorporations

Western Blower Co., Seattle, Wash., capital $15,000. Principal stockholders: J. K. and A. O. Miller.

Steam Specialties Supply Co., Seattle, Wash., capital $20,000. Principal stockholders: A. Boyd, W. L. Collier and F. Carver.

Moseley Plumbing & Heating Co., Wilmington, Del., notice of whose incorporation with a capital stock of $25,000 was announced in our last issue, was incorporated by F. O. Moseley, E. Demarest and C. Romagna, all of Wilmington.

Taylor Heat & Light Co., Columbianna, O., capital $30,000. Incorporators: W. A. Chambers and others.

Advance Water Heater Co., Chicago, capital $10,000, to manufacture water heaters. Incorporators: P. A. Thompson, C. T. Temple and W. H. Gilbert.

Hubbard Caloric Pump & Mfg. Co., West Toledo, O., capital $25,000, to manufacture and sell pumps and other machinery. Incorporators: F. B. Hubbard, B. B. Brim, William B. Duck, F. M. Landis and A. Schaefer.

William J. Wright Corporation, Salt Lake City, Utah, capital $10,000, to conduct a heating and plumbing business. President, William J. Wright; vice-president, secretary and treasurer, I. B. Wright; additional director, Frederick H. Wright.

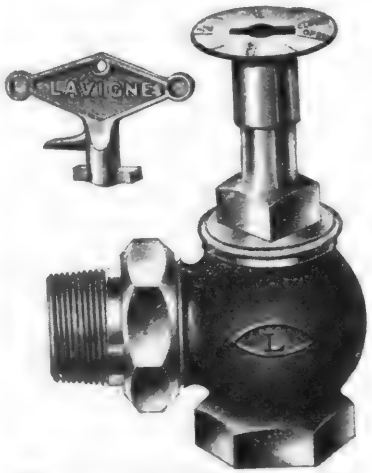
John Richman Plumbing Contracting Co., Bronx, New York, capital $10,000, to engage in heating and plumbing. Incorporators: John Richman, Joseph Lipkoff and Isidor Richman.

Burke Valve Co., Cleveland, O., capital $50,000. Incorporators: W. B. Burke, W. G. Rose, T. H. Duncan, W. H. West and Fred C. Backus.

H. G. Smith Co., New York, capital $12,000, to conduct a heating and ventilating contracting business. Incorporators: Howard G. Smith, 128 Fort Green place, Brooklyn; Alfred A. Driggs, Mountain View, N. J.; and Richard L. Phillips.

E. S. Bradley Co., Manchester, Mass., capital $20,000, to take over the heating and plumbing business of Edward S. Bradley, of that place. President and treasurer, E. S. Bradley; secretary, W. H. Allen.

The Lavigne Graduated Packless Valve
LOCK SHIELD PATTERN

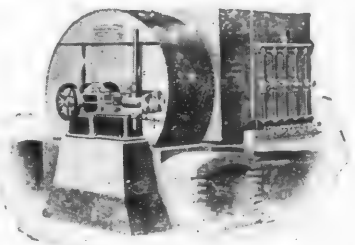


The Lavigne Lock Shield Graduated Packless Valve

Is particularly well adapted for certain classes of work. Each size can be very accurately adjusted to a wide range of sizes of radiators, and the adjusting can be done by the heating contractor when installing the job instead of being done at the factory. It is also Fool Proof. Our Graduated Valves are also made with lever handle indicator. Send for our new circular fully describing our various styles of packless valves. Samples will be sent to interested parties.

Use Lavigne Packless Valves on Your Good Jobs

LAVIGNE MFG. CO., Detroit, Mich.



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¶ Recognition of this truth has made the fan system of heating and ventilating compulsory in schools almost everywhere. That it applies with equal force to factories, mills and shops is proven by the numerous installations of the

Buffalo Fan System of Heating and Ventilating

¶ Ventilation has in many of these been considered of equal importance to heat distribution on account of its close and undeniable relation to health and efficiency of the human machine at work, rest or play.

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Contracts Awarded

U. S. Plumbing & Heating Co., Ontario, Ore., heating, ventilating and plumbing Holy Rosary Hospital, at that place, for $6,326.

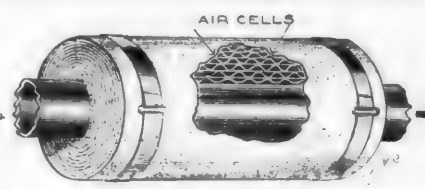
Prox & Burget Co., Terre Haute, Ind., heating and plumbing college and conservatory of music buildings for the Sisters of Providence, at St. Mary's, Ind. The work will cost $35,000.

McGinness-Smith Co., Pittsburgh, Pa., steam heating and ventilating Mt. Washington School, in that city, for $8,000; also heating New Castle High School, for $4,800.

American Warming and Ventilating Co., Pittsburgh, Pa., heating and ventilating school building at Washington, Pa.; also heating and ventilating new $50,000 high school at Freedom.

Chafer Co., Cleveland, O., heating new Statler Hotel in that city. The plumbing contract went to Dewstoe & Brainerd, of Cleveland.

M. D. Holmes & Son, Worcester, Mass., heating new Meade Street Schoolhouse, for $7,926; or without automatic temperature regulation, $7,076. Other bids were: J. W. Callahan & Co., $8,513, $7,696; O. S. Kendall & Son, $8,428, $7,592; Edwin Hawes Co., $8,375, $7,497; A. Burlingame Co., $8,250, $7,372; N. J. Smith, $8,175, $7,365.



J-M Asbestocel Pipe Covering is Fireproof

Being made of asbestos **J-M Asbestocel Pipe Covering** does away with the danger of fire from overheated pipes.

It is the most efficient covering for hot water, hot air and low pressure steam heating systems, because it is built on the principle of the arch with the air cells running around the pipes, instead of from end to end, which construction confines the greatest amount of dead air. Will pay for itself in fuel saved in 8½ months.

Cannot crack, break or lose its insulating value from rough handling or vibration.

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Baltimore	Kansas City	Philadelphia
Boston	Los Angeles	Pittsburg
Chicago	Milwaukee	San Francisco
Cleveland	Minneapolis	Seattle
Dallas	New Orleans	St. Louis
Detroit	New York	(872)

Shields & Liedley, Lansing, Mich., heating and plumbing the E. W. Sparrow Hospital Building, at that place, for $20,000; also heating and plumbing new building for the Michigan School for the Blind and remodeling its power plant and underground piping system, for $13,000.

Oakes Heating & Plumbing Co., Evans City, Pa., heating, plumbing and lighting.

Olean Plumbing & Lighting Co., Olean, N. Y., remodeling steam heating system in buildings of the St. Bonaventure College and Seminary at Allegany, N. Y., for $12,000.

Barlow Bros. Co., Waterbury, Conn., heating and plumbing new building for St. Mary's Hospital at that place.

Buffalo Forge Co., Buffalo, N. Y., forced draft equipment for the Bethlehem Steel Co., necessary to take care of the increased size of its Saucon plant. The contract calls for a 200-in. standard Buffalo steel plate fan, direct-connected to a 10 by 20 in. horizontal side-crank Buffalo steam engine. About six years ago, when this plant was built, six similar Buffalo outfits were installed by this company; also heating and ventilating apparatus for the new stave and heading mill and tub factory of Armour & Co., at Hill City, Minn., including 120-in. Buffalo steel plate exhauster, direct-connected to a 7 by 7 in. Buffalo vertical engine, Buffalo heaters and system of air ducts for the stave and heading mill, and a 100-in. exhauster, driven by a 6 by 6 in. direct-connected Buffalo engine, for the tub mill.

H. B. Smith Co., Providence, R. I., heating and ventilating new Riverside and Rumford grammar schools at that went to Samuel Jackson & Sons, Pawplace, for $5,803; the plumbing contract went to Samuel Jackson & Sons, Pawtucket, at $3,194.

Badger Engineering Co., Milwaukee, Wis., hot air heating system for the paper mill of the Grandfather Falls Co.

F. S. Spencer, Minneapolis, Minn., heating and ventilating new Barnum High School, at Duluth.

McGuire Bros., Rockford, Ill., heating and ventilating P. R. Walker School at Rockford, for $10,387. The company also has the plumbing contract.

William H. Conklin Co., Columbus, O., heating and plumbing State serum farm at Reynoldsburg, for $5,932.

Barbour Heating and Electric Co., Birmingham, Ala., heating Ensley High School at that place, for $12,495.

Ruhaak & Lackman, Pekin, Ill., heating, ventilating and plumbing for the county farm buildings, for $7,800.

Fred Swinth, Chehalis, Wash., heating new hospital building for the State Training School at Chehalis, for $2,193.

Piper Bros., Trenton, N. J., heating and plumbing new school building at the State Home for Boys at Jamesburg, for $4,000.

Lewis & Kitchen, Kansas City, Mo., heating Greene County Court House at Springfield. A steam hot blast system is being installed.

Midgeley Bros. Co., Salt Lake City, Utah, heating plant for new county hospital buildings at that place.

Clark & Jones, Lima, O., heating and ventilating school building at Canton, O.

Modern Heating Co., St. Louis, Mo., heating addition to police headquarters in St. Louis, for $4,419.

Hub Plumbing & Heating Co., Newburyport, Mass., heating and ventilating Curtis school buildings.

John G. Sutton & Co., San Francisco, Cal., boilers and boiler auxiliaries for the City and County Hospital Buildings, for $49,800; also heating Bankers' Investment Building at that place, for $4,969; the plumbing contract for the latter job went to William S. Snook & Son, at their bid of $12,950.

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Robert Dalziel, Jr., Co., San Francisco, Cal., heating new building of the Knights of Columbus, Golden Gate avenue and Leavenworth street, for $9,000.

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Washington, D. C.—Sealed proposals will be received at the office of the Supervising Architect, Treasury Department, for the following-named work:

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Handbook for Heating and Ventilating Engineers. By Prof. James D. Hoffman and Benjamin F. Raber. The latest book on this subject. Unusually comprehensive. 320 pages, with 45-page appendix. Size 4½x6¾ in., bound in flexible leather. Price. $3.50.

Questions and Answers on the Practice and Theory of Steam and Hot-Water Heating. By R. M. Starbuck. Illustrated. $1.00.

Ventilation of Buildings. By William G. Snow and Thomas Nolan. 83 pages. Pocket size. Contains a statement of the general principles of ventilation and of their application to different kinds of buildings. Boards, 50c.

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Air-Conditioning. By G. B. Wilson. Being a short treatise on the humidification, ventilation, cooling and the hygiene of textile factories—especially with relation to those in the U. S. A. With figures. 12mo. Illustrated. 143 pages. Price, $1.20.

Steam-Electric Power Plants. By Frank Koester. A practical treatise on the design of Central Light and Power Stations and their economical construction and operation. 473 pages. 340 ills. Price, $5.00.

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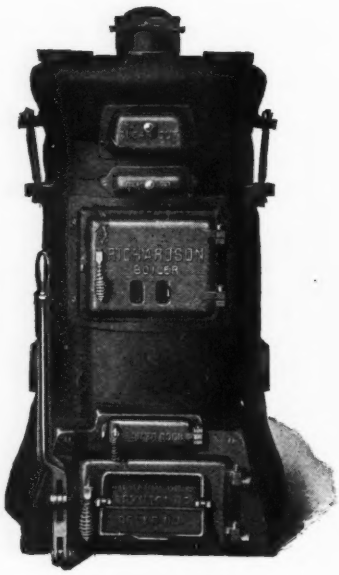

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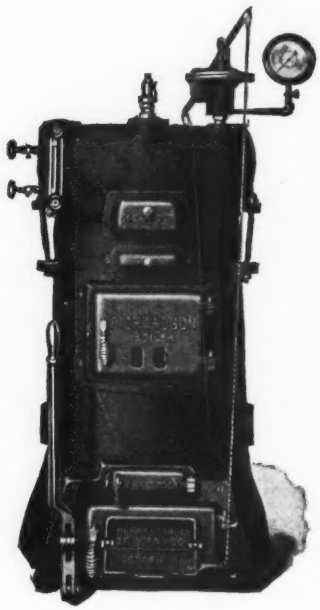

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